HOME POWER

THE HANDS-ON JOURNAL OF HOME-MADE POWER

Issue #53 June / July 1996

Features

GoPower

Fundamentals

Features

Cover: Ali Cotterell at the helm of Gebroeders, her live-aboard sailboat with PV and wind power. Story on page 12.

Access and Info

Access Data

Home Power Magazine
PO Box 520,
Ashland, OR 97520 USA

Editorial and Advertising:
916-475-3179 voice and FAX

Subscriptions and Back Issues:
800-707-6585 VISA / MC

Computer BBS:
707-822-8640

Internet E-mail:
hp@homepower.org

World Wide Web:
http://www.homepower.com/hp

Paper and Ink Data

Cover paper is 50% recycled (10% postconsumer and 40% preconsumer) Recovery Gloss from S.D. Warren Paper Company.

Interior paper is recycled (30% postconsumer) Pentair PC-30 Gloss Chlorine Free from Niagara of Wisconsin Paper Corp.

Printed using low VOC vegetable based inks.

Printed by

St. Croix Press, Inc.,
New Richmond, Wisconsin

Legal

Home Power (ISSN 1050-2416) is published bi-monthly for $22.50 per year at PO Box 520, Ashland, OR 97520. International surface subscription for $30 U.S. Second class postage paid at Ashland, OR, and at additional mailing offices. POSTMASTER send address corrections to Home Power, PO Box 520, Ashland, OR 97520.

Recycled Paper

Recyclable Paper

What's it worth?

What is electrical energy produced by renewable resources worth? I guess it depends on who you are. For us (the Home Power Crew on Agate Flat) renewable energy is worth quite a bit. RE gives us the freedom to live and work where we want—beyond the power lines. It means we don't have to operate a smelly, noisy, and expensive generator all the time. RE gives us the satisfaction of knowing where our power comes from. For us, these freedoms are worth far more than we paid for the RE hardware.

America's utilities, however, place a far lower value on renewable energy. For example, see the article about Dan and Lori Whitehead which begins on page 6 of this issue. Dan and Lori have a utility intertied wind electric system. They can buy power from the utility at a rate of 10.5 cents per kiloWatt-hour. The utility pays Dan and Lori 1.7 cents per kiloWatt-hour for their surplus wind electricity. This means that for every kiloWatt-hour of energy that Dan and Lori buy from the utility they must generate 6 kiloWatt-hours in order to break even. Basically the utility is telling Don and Lori, "Our energy is six times more valuable than your wind-generated electricity."

Is utility-supplied energy really worth six times more than renewable energy? I think not. RE is produced using clean, nonpolluting sources such as sunshine, wind, and falling water. Utility-supplied energy comes from combustion (coal and natural gas), from nuclear reactors, and to a limited extent, hydroelectric on dammed rivers. To be sure, utilities have their operating costs—about half their money goes into power transmission. But, with the exception of hydro, the utilities' energy comes from non-renewable resources and pollutes our environment with everything from acid rain to radioactive waste (and how much is this pollution worth?). And yet utility-supplied energy is, at least in the eyes of the utility, worth six times more than renewable energy. Why?

Well, I'd hazard a guess that greed may have something to do with the utilities' inflated evaluation of their energy. After a hundred year monopoly on electric power production, utilities don't want any competition. They are happy with the status quo—they make the power and you rent it. Solar, wind and hydro are forms of energy which are democratically delivered everywhere—a gift of nature. These natural energy resources don't fit into the utilities' monopolistic mode of operation. How can they rent you power which is freely and naturally delivered to you each day? Well, they can talk you into a grid intertied system where they pay you a pittance for your power. Then the utility can turn around and sell your RE to someone else or even back to you—thus ensuring their monopoly and their profits.

The time has come for us to demand a fair price for our power. If we don't get it, then pull the plug on utility power. We are not required to buy their polluting energy. We are not required to sell our renewable energy to utilities for less than it is worth. We are not required to fatten the utilities' coffers by allowing them to profit from our renewable energy.

While universal cooperation and sharing of RE is obviously the way of the future, utilities cling to the way of the past—they make the power and you rent it. We know a better way….

Times they are a changin'

Richard Perez for the Home Power Crew

People

Sam Coleman
Martin Cotterell
Mark Green
Michael Hackleman
Kathleen Jarschke-Schultze
Bruce Johnson
Stan Krute
Dick Linn
Don Loweburg
Rob Magleby
Robert Morris, Jr.
Karen Perez
Richard Perez
Shari Prange
William Raynes
Benjamin Root
Mick Sagrillo
Bob-O Schultze
Harold Sexson
Tina Sorenson
Jaroslav Vanek
Steven Vanek
Michael Welch
Daniel Whitehead
John Wiles
Myna Wilson

"Think about it…"

"The way I see it, if you want the rainbow you gotta put up with the rain"

Dolly Parton

Alternative Energy ...or Just Plain Crazy

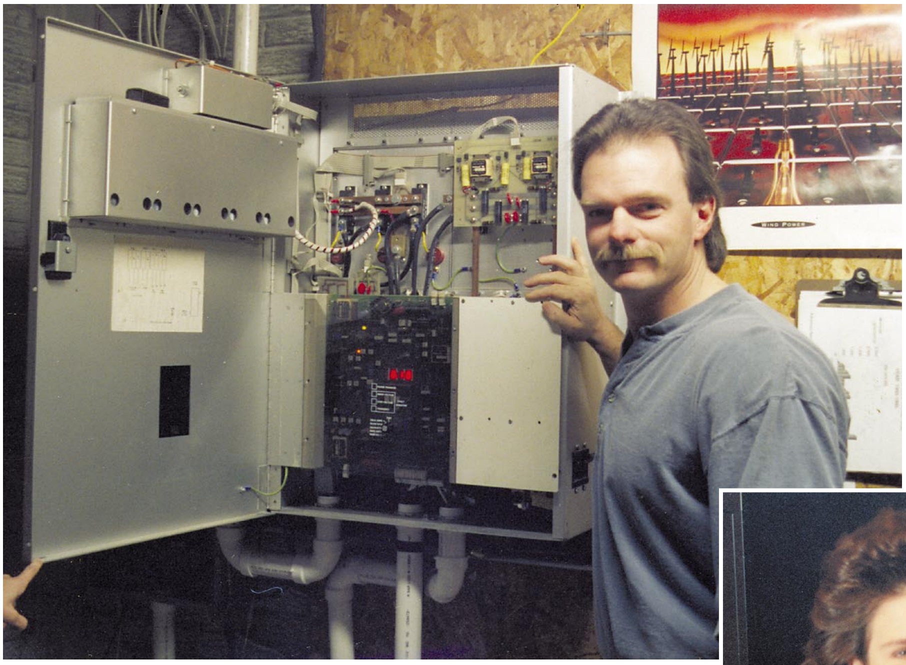
Daniel Whitehead

I started experimenting with alternative energy back in the late 1970s. I built hot air solar panels from 2 by 4s and empty beer cans cut in half. They worked well but had quite an odor until the smell burned out of them. I installed my first wind generator in 1984. This was a 450 Watt Winco charging a 12 Volt battery bank. After this I was hooked. The next year I installed a 12.5 kiloWatt Jacobs on a 100 foot tower in the middle of the city. Public acceptance was not favorable, to say the least. The machine did not produce well because of the surrounding terrain. I let my enthusiasm overrule better judgement. Never put up a wind generator within the city limits. Between the fight with neighbors and the city fathers it is not worth it.

Solution: Move to the Country

In 1992 we bought 32 acres in the quiet countryside of Morrison, Illinois. We spent the first year building a 1600 sq foot log home that we designed. The home has a large south facing side that is mostly glass. I installed two 450 Watt Winco wind generators out at my shop building to run some lights and to check out the wind potential of our site. The wind at our site proved to be very good. I was pleased with the results so the next year we started looking for a used 17.5 kW Jacobs for the first part of our renewable energy venture. After talking with the local utility (Common Wealth Edison) and checking on local codes and variances, the project was a go. We pay 10.5 ¢/KWH for the power we buy and get paid 1.7 ¢/KWH for power we sell to our utility.

We located a rebuilt machine with a 120 foot angle-iron tower. My creative wife, Lori, put together an impressive presentation for a local bank and they agreed to finance the project. When the machine and tower arrived my yard looked like a giant erector set. We dug three holes for the footings 8 foot square by 8 foot deep. The 20 foot bottom section was assembled complete with anchors and stood up in the holes. We used a transit to level the base then assembled the rebar cage around the legs. The cement was poured in two phases. The first was the 8 by 8 by 2 foot thick pads. After these had set we built 2 foot square piers that came up level with the top of the holes. The cement trucks came back and poured these piers around the legs and the cement



Left: Dan Whitehead shows off the inside of the Jacobs intertie inverter which converts 3-phase wild ac into single-phase 240vac.

Below: Lori Whitehead monitors wind system data on her personal computer.

work was done. We backfilled the holes and let it set up for a couple of days.

The tower is hinged at the base so we simply lowered the 20 foot base section using a pickup truck and a cable. Next we assembled the rest of the tower on the ground and finally mounted the generator on the top section. The governor, blades, and tail were all installed with the tower still on the ground. We dug a trench to the house and connected the wiring from the tower to the basement where the inverter would be housed.

Up, Up and Away!

We hired a local crane operator to lift the tower into position. This was his first job with a wind generator and he was very excited. We went over the details of the raising. He would lift the tower and generator together to about a 50-60˚ angle then a large winch truck would pull it the rest of the way. When we were both satisfied with the details it was time to go to work. Lori video taped the lift and all the neighbors within a couple of miles were there to watch.

I was a nervous wreck during the lift but all went very smooth, just as planned, with no problems. What a relief it was when the tower was standing upright and I put that first bolt in to secure the leg to the base.

Make Some Electricity

This makes the fifth wind generator that I have installed and there is no other feeling like the moment you first take the brake off and let your machine start running. This time was no exception. My heart raced as I cranked the brake off and waited for the wind to take over. Within moments the blades started to spin and we were on line producing about 5 kW in the light breeze. We just stood and watched it for awhile. It has a hypnotic effect like watching a campfire in the night. It was a beautiful sight indeed.

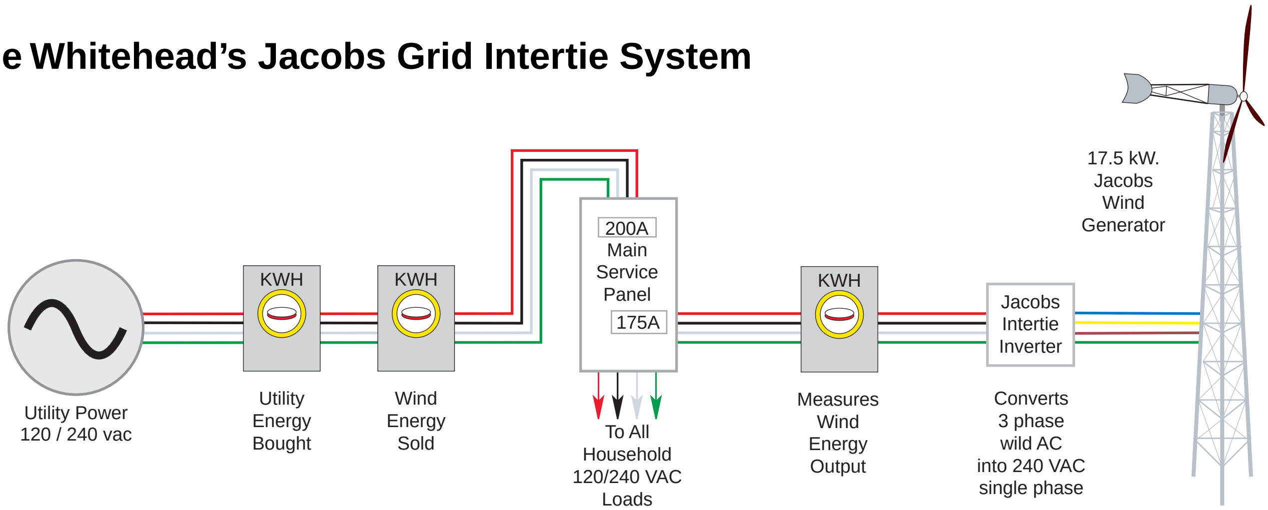
Time for an Upgrade.

The machine ran well for the first two years. This year we installed a set of carbon fiber blades made by Advanced Aero Technologies. These blades will increase the annual output by about 30%. They are remarkable blades that resist icing in the winter and will last for many years without needing to be refinished. Since we installed these blades in September we have been making record production every month. It looks like the expected annual increase will easily be made.

What's Next? Solar, of Course.

After attending the Midwest Renewable Energy Fair in Amherst, Wisconsin in 1994, I was ready to try solar again. The wind machine produces three times more electricity than we use but you can never have too

The Whitehead's Jacobs Grid Intertie System



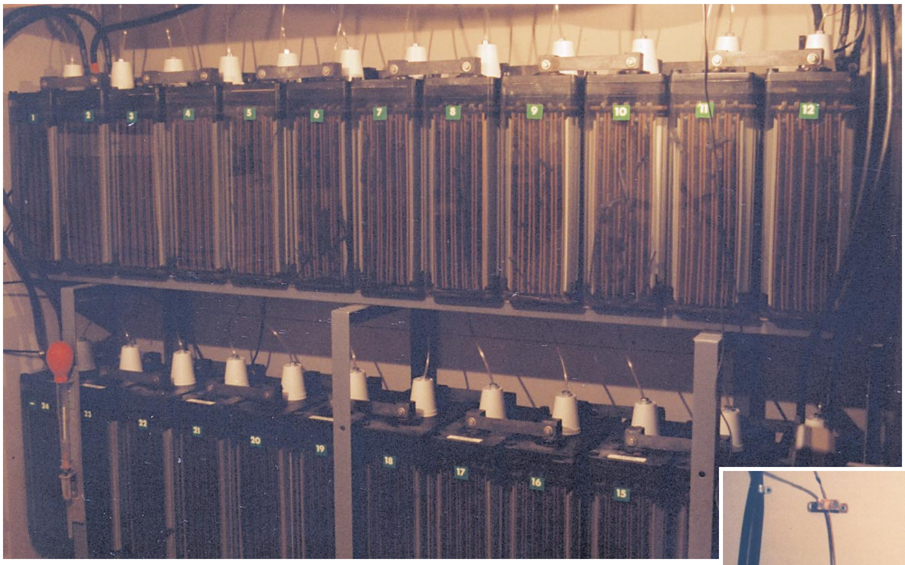
much power. I have a 40 by 80 foot shop that I wanted to use for the solar installation. I found a set of 840 Ah used telephone company batteries that would work for this project. After moving 48 batteries at over 300 lbs each, I was tired at the end of the day.

I designed the system and then faxed it to Bob-O Schultze of Electron Connection for his input. After he made a few changes and suggestions, I ordered the parts. We went with the Trace DR2424 inverter and four Siemens 75 W PC4 modules, to be expanded to eight modules this year. I went with a fixed mount system and the Heliotrope CC60E controller. I also used the Cruising E-Meter to monitor system performance.

The panels are wired in series-parallel for 24 Volts and 18 Amps. #10 wire connects them all together with plastic weatherproof conduit and #4 wire from the combiner box to the controller in the shop. I constructed a 10 by 10 foot room to house the batteries and controls. I use a hydrogen collection system that I saw in HP#6 in an article by Gerald Ames. I used cups covering the battery vents and plastic tubing to connect them all to the main PVC pipe to vent the hydrogen outside the battery room. The room is insulated and I run a small heater in the winter to keep things at 60˚F.

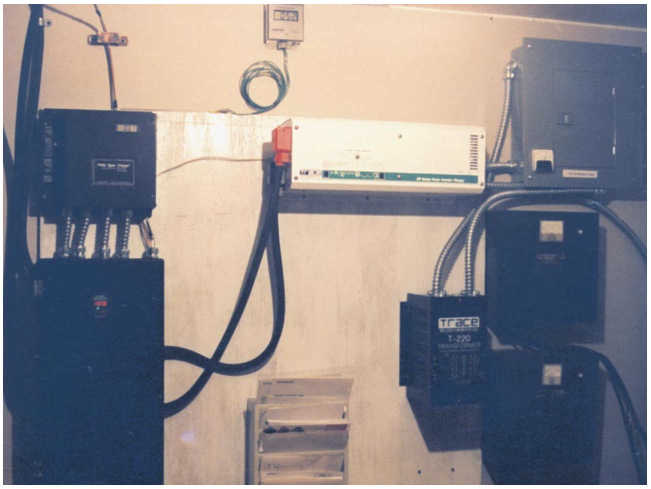
After mounting and wiring the system we were ready to test it out. It is always a tense moment when you first power up electrical equipment. All went well and I started wiring my shop equipment into the breaker box from the Trace. I am currently running nine fluorescent shop lights, a drill press, a band saw, two lathes, a grinder, a 1 hp door opener, and anything else that gets plugged into the wall outlets. I still have a 220 volt air compressor and welder that runs from the grid or the Jacobs when the wind blows. I have a 1000 W Whisper wind generator that I am installing into this system to help with the load demands of the shop. This will give me four wind generators and a PV system.

Above: Dan & Lori on the porch of their renewable energy-powered home in Morrison, Illinois. A 17.5 kW Jacobs on a 120 foot tower provides power.



Left: Twenty-four Gould lead-acid cells make up the 24 Volt, 1680 Amp-hour battery bank. Each cell weighs over 300 lbs.

Below: The control board for the photovoltaic system. Notice the rack that keeps documentation for the components organized and handy.

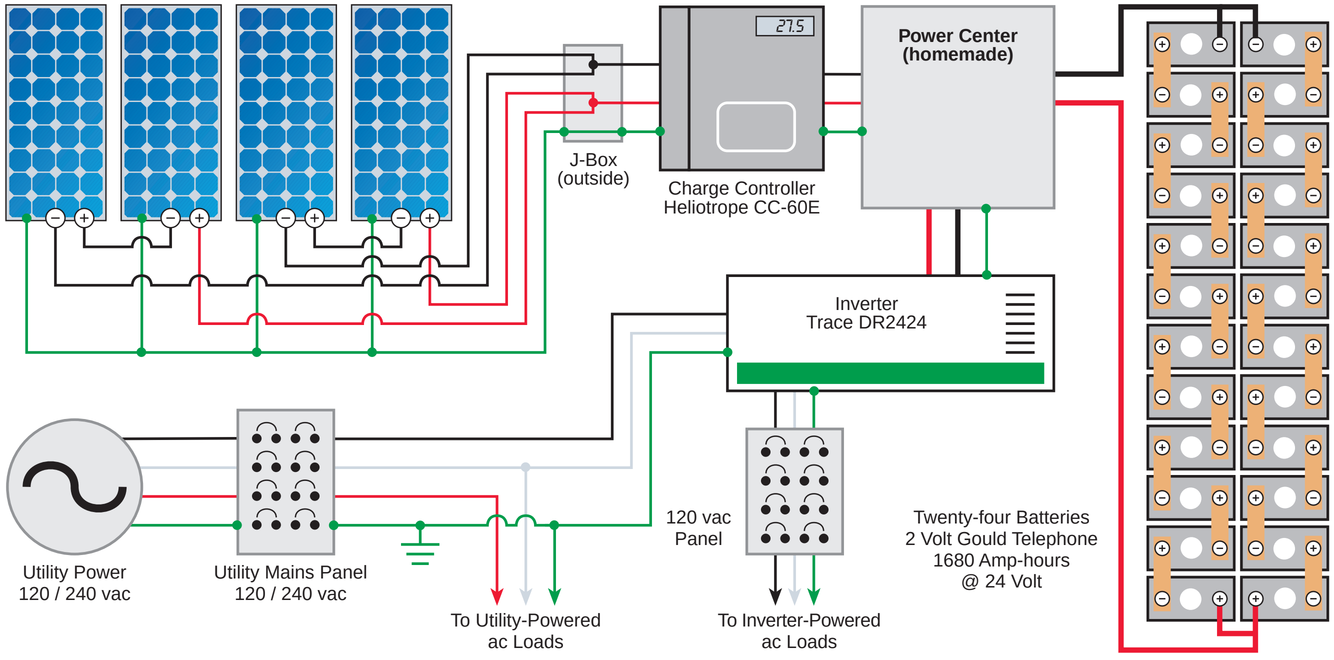


I am very happy with the outcome of the project. Thanks to Bob-O Schultze for the technical support and Lori for maintaining her sense of humor through these projects.

What's in the Works After All This? An Electric Vehicle, of Course.

Like I asked earlier, "Alternative energy, or just plain crazy?" I think all of us that are involved with renewables are a little crazy. It takes a little more effort on your part to have one of these systems, but the rewards are well worth the effort. If it was easy,

The Whitehead's Photovoltaic System



Whitehead Wind System Cost

System Component	*Cost*	*%*
Rebuilt 17.5 kW Jacobs	$12,000.00	75.1%
Concrete & rebar	$1,577.60	9.9%
Wire and Miscellaneous	$867.01	5.4%
Angle Iron	$410.52	2.6%
Utility Company Fee	$300.00	1.9%
Misc. Electrical Parts	$291.00	1.8%
Crane	$216.00	1.4%
Backhoe w/ Operator	$175.00	1.1%
Anchors	$150.00	0.9%
Total	$15,987.13	

Whitehead Wind System Performance

Time Period	*KWH per Year*
October 1993 to October 1994	15,460
October 1994 to October 1995	16,090
October 1995 to April 1996 *(7 Months)*	15,290

Note: AAT carbon glass fiber blades installed in September 1995

Above: Two 450 Watt Winco generators provide power for the shop. The PV mount has room for four more Siemens PC4 photovoltaic panels.

Whitehead PV System Cost

System Component	*Cost*	*%*
4 Siemens PC4JF Panels	$1,580.00	37.0%
Trace DR2424 Inverter	$900.00	21.1%
Zomeworks Panel Mount	$416.60	9.8%
Heliotrope CC60E Control	$361.25	8.5%
Trace T-220 Transformer	$265.00	6.2%
Cruising Equip. E-Meter	$179.00	4.2%
Miscellaneous	$176.00	4.1%
30 feet 0000 Cable	$122.00	2.9%
24- 840 A-h Batteries	$100.00	2.3%
PVC Pipe and Ground Rod	$52.27	1.2%
Lightning Arrestor	$45.00	1.1%
24 Plastic Battery Boxes	$44.81	1.1%
70 feet #4 Wire	$23.00	0.5%
Total	$4,264.93	

everyone would do it. It must be the satisfaction of doing something truly good for yourself and the environment that drives us. Sitting back watching the wind and sun produce clean, free energy is my idea of fun in the country.

Access

Author, Dan Whitehead, Illowa Windworks, 12197 Nelson Rd. Morrison, IL 61270 • 815-772-4403

Introducing Trace Engineering's New...

POWER PANEL SYSTEMS©

Now, buying a fully engineered, professionally assembled alternative energy system is easy as calling your TRACE dealer. You can be assured of code compliance and quality components since its factory built and tested by the people who build the world's most advanced and reliable inverters. Trace Engineering!

SW SERIES POWER PANEL SYSTEMS©:

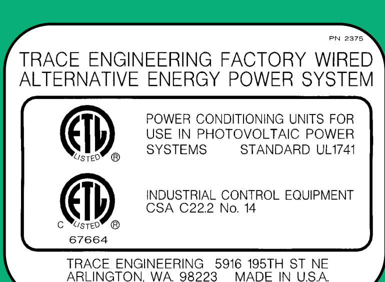
- **Sine wave AC power inverter with high efficiency operation and bidirectional operation (inverting, charging or utility interactive).**
- **Up to 16 kW of continuous AC power (120/240 vac systems).**
- **Up to 60 amps of AC input from a generator or utility grid.**
- **Three stage, temperature compensated, battery charging**
- **Utility interactive and generator support operating modes.**
- **Can regulate up to 5.6 kW of solar or other DC charging sources.**
- **Available outputs of 105, 120, 230 or 120/240 vac at 50 or 60 Hz.**
- **Available for 12, 24 or 48 volt DC systems voltages.**
- **Sizes 120 VAC-60Hz - 2.5 / 4.0 / 5.0 / 5.5 / 8.0 / 11.0 kW.
120 / 240 VAC-60Hz - 5.0 / 8.0 / 11.0 / 16.0 kW.
230 VAC-50Hz - 3.3 / 4.2 / 6.0 / 7.5 / 9.0 / 11.0 kW.**

DR SERIES POWER PANEL SYSTEMS©:

- **Modified Sine wave AC power inverter with high efficiency operation and battery charging ability.**
- **Up to 7.2 kW of continuous AC power (120/240 vac systems).**
- **30 amps of AC pass through power at 120 or 120/240 vac from a generator or utility grid to your loads in addition to the charger draw.**
- **Three stage, temperature compensated, battery charging — up to 240A @ 12 VDC, 140A @ 24 VDC.**
- **Can regulate up to 2.8 kW of solar or other DC charging sources.**
- **Available outputs of 105, 120, 230 or 120/240 vac at 50 or 60 Hz.**
- **Available for 12 or 24 volt DC systems voltages.**
- **Sizes 1.5 / 2.4 / 3.0 / 3.6 / 4.8 / 7.2 kW.**

ALL POWER PANEL SYSTEMS INCLUDE©:

- **Powdercoated steel backplate prewired with all NEC/UL required AC & DC overcurrent protection and disconnects— Simply connect to the battery and AC loads and your system is operational.**



- **Single or dual C40 charge controllers can be used with solar, wind or hydro DC charging sources. Up to 1.4 kW @ 12 VDC, 2.8 kW @ 24 VDC or 5.6 kW @ 48 VDC. 60A disconnect is included for each controller.**
- **60 amp AC system bypass allows servicing or removal of the inverter while keeping AC loads connected to the generator or utility grid.**
- **Optional non-metallic battery enclosure which doubles as a shipping enclosure — Measures 43.8" (112 cm) wide, 48" (122 cm) long & 29.3" (75 cm) high.**
- **Flexible conduit for connection of the system to the battery enclosure.**
- **Up to 16 kW Available Soon !**

Trace Engineering 5916 - 195th Northeast Arlington WA 98223 (360) 435 - 8826 Fax (360) 435 - 2229

Wind & Solar Power on the Water

Martin Cotterell

Above: Gebroeders is a home under sail for Martin and Ali (photo prior to the installation of PV modules).

Gebroeders is 117 years old, yet was built with renewable energy firmly in mind. What could be more renewable than using the wind to propel her iron frame to deliver her cargoes. Long since out of commercial service, Gebroeders is now my home—moored in a small tidal estuary in southeast England.

Over the years the energy used to power Gebroeders became less renewable with the addition of an engine and electrical system. I like to think that I am now reversing that process. Rather than using dirty diesel I sail her whenever I can, and Gebroeders' rigging is now also capturing the wind to generate electricity.

Wind on the Water

Part of my desire to live afloat was driven by the potential to be independent of the grid. Within a week or so of buying the boat I was installing my Ampair wind generator. I wanted it to be high, but did not want to mount it on the beautifully varnished mast and clearly it had to be out of the way of the sails. The solution I adopted was to hoist the generator up the forestay. This meant that it has to come down every time I sail, but that seemed the best solution. I spliced three rope stops which are attached to bolts on the Ampair. These are hung from the forestay via a galvanized anchor swivel to allow the machine to yaw. A short section of pole beneath the generator is secured to three guys. Raising and lowering the machine is easy—I simply clip it onto the foresail sheet and pull until the three guy ropes become taut, holding the generator firmly in place and away from the mast and any ropes. This has proven to be a very reliable system and has survived many a gale.

A Splash of Solar

With the introduction of a new source of power, a few horrors of her previous modernization began to emerge. Lights dimmed and flickered as I turned on appliances. Although I found cables to be comfortingly thick throughout most of the boat, these were bridged by small sections of thin cable with alarming twisted wire junctions. Lurking in the depths of the bilge, hidden by insulation tape, I found an appalling junction of thin wire

coming from the batteries. This turned out to be the battery connection for most of the boat's wiring. Over time, I have had to rewire most of the boat.

I survived for a while with just my Ampair, but electricity demand soon drove me to buy a solar panel. The electrical installation was straight forward but again mounting was awkward. Although there is plenty of space on the boat, when she is sailing most parts are crossed by flying sails, ropes and shackles, or shaded by the rigging. I tried simply laying the panel on the deck, moving it out of the way when sailing, as I did with the wind genny. However, I soon abandoned this plan when I nearly lost it overboard at sea.

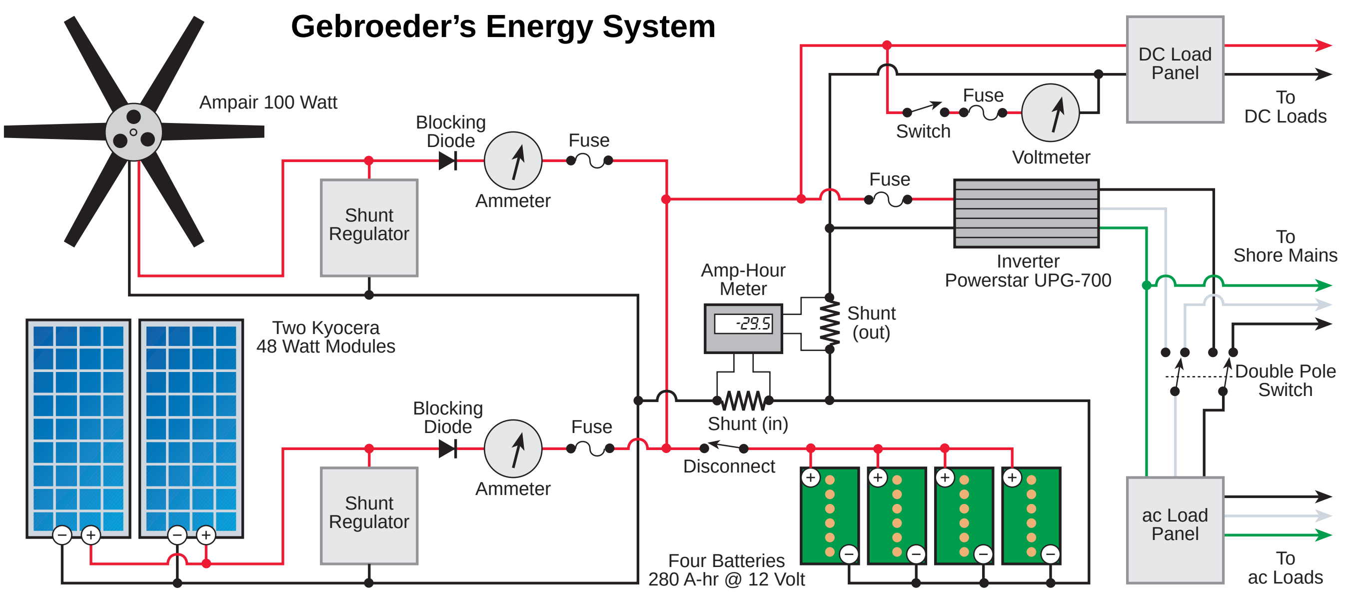
There were three problems to overcome in positioning the solar panel. The first was shading caused by so much mast and rigging towering over the boat. The second was the need to protect the panel from moving sails and ropes when sailing. The third was how to maintain the aesthetics of a beautiful and historic boat. The answer I came up with was to mount the panel on a pole attached to the rudder. This position does not detract too much from the appearance of the boat and is well out of the way of ropes and rigging. It also has the added benefit that by turning the wheel I can manually track the sun, although this is not recommended practice while out sailing!

Above: The Kyocera modules are mounted on the rudder post keeping them out of the way of lines and other activity on deck.

Above: Martin hoists the Ampair into position.

I have found that the combination of the Ampair and now two solar panels generates all the power that I need. For storage, I started off with some second-hand telephone exchange gel-cell batteries but eventually had to give up on them as the lights began to pulse in brightness with the wind. I now have four 70 Ampere-hour wet cell lead acids.

I had previously avoided wet cells as the thought of acid leaking out when the boat pitched and eating away at the hull was unattractive, to say the least. However, a good battery box, safely secured, has alleviated these fears. I still have not fully secured all items in the boat, and the fridge is wont to wonder across the kitchen on occasion. But then, work on a boat is never done.



Above: The Ampair hoisted into "flying" position hangs from the foresail sheet in the triangle between the mast and the forestay.

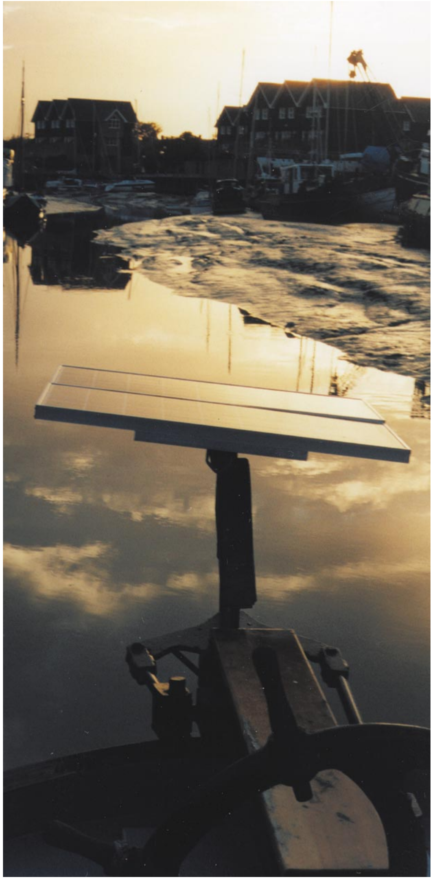
I use a voltmeter, homebrew Ah meter, and a couple of ammeters to monitor the system. The ammeter for the wind generator has a dual function—10 Amperes means it is not a day for sailing and I think twice about going out! The Ah meter was built from a *Home Power Magazine* circuit.

The load on the boat is mostly lighting and the water pump. A Powerstar 700 watt inverter is used to run various 240 vac loads including my computer and TV. It also powers my old valve amplifier for the stereo. I know that valves are hopelessly inefficient but I wouldn't change it for the world. I would rather switch off some lights.

Living off the grid and away from normal services, even if they are just up the creek, feels good, as I'm sure every remote boat or cabin dweller knows. I could have chosen to plug into the mains onshore but I am happy with the knowledge that all that ties me to the shore is a couple of knots.

Access

Author: Martin Cotterell, Sunpower, c/o Mill Cottage, Seisdon Road, Trysull, UK, WV5 7JF



Above: The PV modules, and the harbour itself, reflect the setting sun in a placid scene of Gebroeders at its mooring.

ANANDA POWER TECHNOLOGIES

four color on film negatives

full page

This is page 15

South Facing Passive Solar Room

Harold Sexson

Above: Harold poses in his newly completed solar room with its beautiful terra cotta floor

If you have a south facing side of your home that will accommodate a solar room, you can have years of enjoyment and energy savings. Ours includes tile floors, ceiling fans, and seating areas. Here's how to build one.

Solar Room Pointers

- A south facing patio or open unshaded area is the start for a solar room addition to any house. The longer the room, the more solar gain in the winter months and the more tolerant it can be of fluctuations in the weather.
- The more rooms of the house that open into the solar room, the more heat can be used in the house without fans or blowers. Cutting a door or two into the home where windows exist may help.
- Flooring should be reasonably dark to absorb most of the sun's warmth.
- The better insulated the room is, the longer the heat will stay.
- Added thermal storage in the room will help during longer periods without sun.

Length of Our Room

This house already had a 36 foot long south facing patio with 3 foot tall railings all around. The first thing I did was remove the railings and extend the patio length another 14 feet to include the last bedroom on the end of the house. This also improved access to two bedrooms and the living room and, after adding a door, to the family room.

Roof Line

Having the roof line match was a challenge since the foam roof (polyurethane, common in the Phoenix area)

should look the same as the existing roof. This was done by having the same company that replaced the roof a year before add the foam to the new section.

Eves

The existing eves on the house were one foot wide which was perfect for the ten foot width of the room. In the heart of winter the sun shines on the entire tile floor and my thermal storage (adobe bancos). This makes it enjoyable to walk on the warm floor in the evening when it is cold outside. In the summer the sun does not shine on the floor at all and the floor is cool.

Sliding Doors

The eight double pane sliding glass doors were purchase used. All of them look the same for aesthetics. Since the posts for the original patio were not placed for even spacing, they were moved by a few inches to accommodate the doors. Each door is a standard six foot door, with two placed between each post.

Above: Harold finishes the installation of foam board insulation on the ceiling

Insulation

Insulating the ceiling and end walls was next. Before installing the insulation, aluminum foil was pressed up against the existing ceiling and walls to add additional radiant heat barrier. The insulation is Celotex "Blackore," one inch thick with foil on both sides. These were cut to the width between the 2X6 studs and force fitted. Three layers were added making sure there was an air gap between each sheet to add to the thermal reflection. Each sheet has a 7.2 R value, making the 5.5 inch (a 2X6 is really only 5.5 inches) space a respectable R-21.6. This would not be possible with standard fiberglass insulation. Although cheaper, R-14 would be the limit.

End Windows

One window was added in each end. Double paned sliders were used here, as well.

Flooring

Saultio tile was used because it fit the style of the house and it was a less expensive option. Patterns were made in the flooring to add some "homey" atmosphere and get away from the hall-like appearance of the long room. A tile saw was necessary for the cuts to make the patterns. After laying out all the whole tiles, the tile saw cut all the other tiles in one day.

Banco

The seats for most of the solar room are made of adobe brick. They were made from the dirt in the back yard. Although brick making is a long process, it provides excellent thermal storage, provides nice seating for the room, and fits the decor of the home. They were covered with expanded metal and plastered with an elastomeric stucco made by Sto that will not crack if movement in future years occurs.

Ceiling Fans

Three ceiling fans were added to increase lighting and the circulation of the air when sitting in the room. By running the fans in opposite directions we get a circular flow in the room.

Paint

An insulating paint was used that was made by Insulating Coating Corporation (Aztec #300 interior paint). It acts as a sound deadener and insulates to R-20 in the summer and R-5 in the winter. Although more expensive per gallon, the paint lasts ten years and can be made in any color.

Summer

Summer months in the solar room are not as hot as would be expected. A high efficiency evaporative cooler is in one end of the room. Using a thermostat, the cooler not only keeps the solar room cool, but also the rest of the house. On high humidity days the doors to the house are closed and the windows are opened in

Below: Covering the adobe bancos with expanded metal prior to the application of the stucco.

the solar room to let the heat out. The house is also cooled by standard refrigeration during this time.

Transition Months

In the transition months the sliding doors are open to either let the heat out or capture cool evening air. By opening the house doors we can maintain comfortable temperatures without heating or cooling. Occasionally the blower in the cooler is used to blow out the warm air in the house for a few minutes.

Savings

The cost savings to heat the house in the winter is dramatic. When Phoenix had 20˚ mornings in January and 50-55˚ highs during the day, the total heating bill was only 14 dollars over the normal gas hot water and dryer. The typical temperature of the room in the winter is 80˚ in the daytime and 68-70˚ in the morning.

There are other basic assumptions that must be considered when figuring how much savings there are with the room. First is how much the doors are left open or continuously opened and closed. This is a big factor in the winter if traffic is present. We do not leave the doors open in winter except to pass through.

Second is your personal comfort zone. If you are cold or hot with only a couple of degrees fluctuation in temperature, the savings will be minimal. We have a summer maximum in-house temperature of 80˚ if the humidity is low, and 65˚ in winter. We wear winter clothes.

Total Cost

I built the entire room myself, except for the foam on the roof and the drywall hanging and finishing. The total cost was about $4,000 and about six to nine months of working evenings and weekends. I figure the pay-back time to be about five to eight years.

Conclusions

Based loosely upon a green house, the solar room is not a new concept. An excellent book on greenhouses is Bill Yanda and Rick Fisher's The Food and Heat Producing Solar Greenhouse.

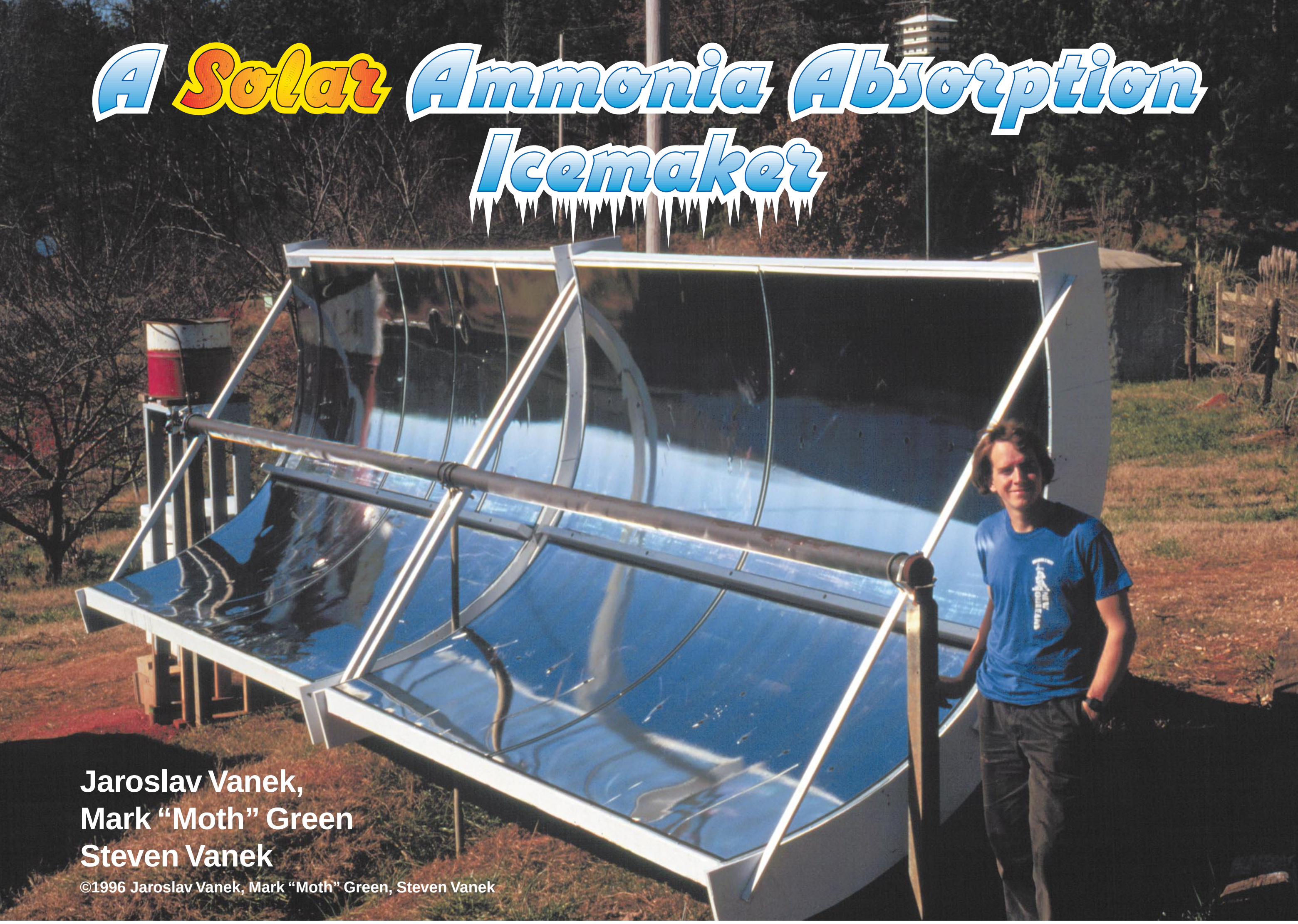
The room is a useful area for gatherings and children's play area. It added value to the home and gave us energy savings. Adapting a design to your particular home is a challenge that should start with a sketch of the south facing side of your home. Make pencil sketches so they can be changed easily. Even letting things sit for a while can help break through a block in the design. And remember, the sun's heat is free.

Access

Author: Harold L. Sexson, 5445 East Caron Street, Paradise Valley, AZ 85253 • 602-998-9055 • FAX 602-998-9067

The Food And Heat Producing Solar Greenhouse by Bill Yanda and Rick Fisher, ISBN 0-912528-20-6

A Solar Ammonia Absorption Icemaker



Jaroslav Vanek,
Mark "Moth" Green
Steven Vanek

Above: Steven Vanek with his machine which uses solar thermal energy to make ice.

Everywhere in our world, refrigeration is a major energy user. In poor areas, "off-grid" refrigeration is a critically important need. Both of these considerations point the way toward refrigeration using renewable energy, as part of a sustainable way of life. Solar-powered refrigeration is a real and exciting possibility.

Working with the S.T.E.V.E.N. Foundation (Solar Technology and Energy for Vital Economic Needs), we developed a simple ice making system using ammonia as a refrigerant. A prototype of this system is currently operating at SIFAT (Servants in Faith and Technology), a leadership and technology training center in Lineville, Alabama. An icemaker like this could be used to refrigerate vaccines, meat, dairy products, or vegetables. We hope this refrigeration system will be a cost-effective way to address the worldwide need for refrigeration. This icemaker uses free solar energy, few moving parts, and no batteries!

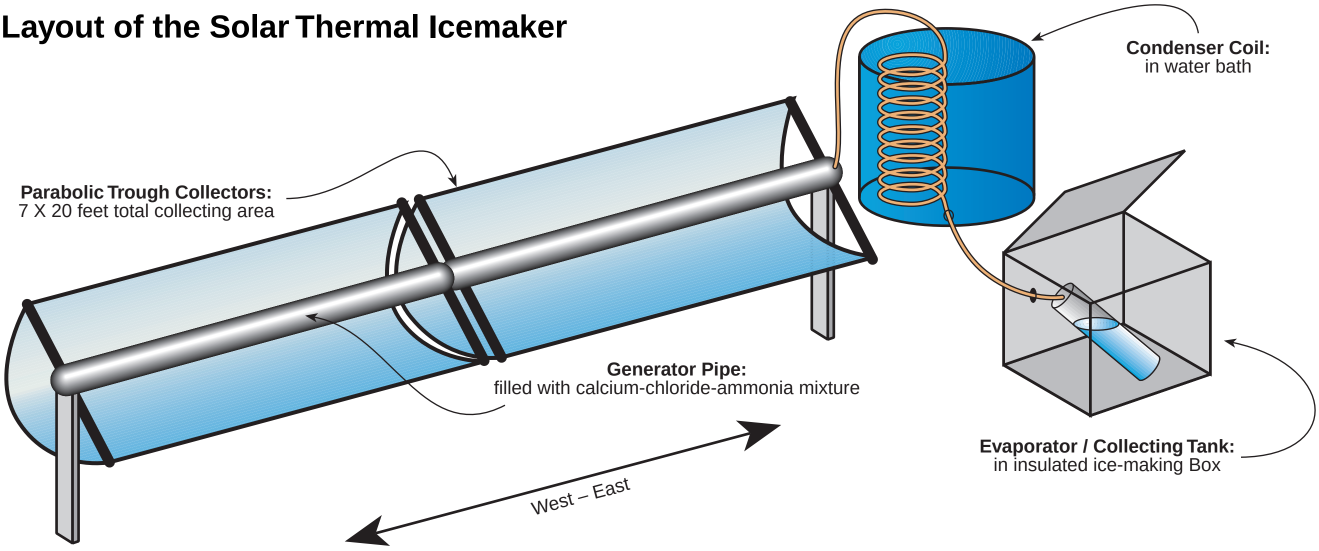
Types of Refrigeration

Refrigeration may seem complicated, but it can be reduced to a simple strategy: By some means, coax a refrigerant, a material that evaporates and boils at a low temperature, into a pure liquid state. Then, let's say you need some cold (thermodynamics would say you need to absorb some heat). Letting the refrigerant evaporate absorbs heat, just as your evaporating sweat absorbs body heat on a hot summer day. Since refrigerants boil at a low temperature, they continue to evaporate profusely — thus refrigerating — even when the milk or vaccines or whatever is already cool. That's all there is to it. The rest is details.

One of these details is how the liquid refrigerant is produced. Mechanically driven refrigerators, such as typical electric kitchen fridges, use a compressor to force the refrigerant freon into a liquid state.

Heat-driven refrigerators, like propane-fueled units and our icemaker, boil the refrigerant out of an absorbent material and condense the gaseous refrigerant to a liquid. This is called generation, and it's very similar to

Layout of the Solar Thermal Icemaker



the way grain alcohol is purified through distillation. After the generation process, the liquefied refrigerant evaporates as it is re-absorbed by an absorbent material. Absorbent materials are materials which have a strong chemical attraction for the refrigerant.

This process can be clarified using an analogy: it is like squeezing out a sponge (the absorbent material) soaked with the refrigerant. Instead of actually squeezing the sponge, heat is used. Then, when the sponge cools and becomes "thirsty" again, it reabsorbs the refrigerant in gas form. As it is absorbed, the refrigerant evaporates and absorbs heat: refrigeration!

In an ammonia absorption refrigerator, ammonia is the refrigerant. Continuously cycling ammonia refrigerators, such as commercial propane-fueled systems, generally use water as the absorbent, and provide continuous cooling action.

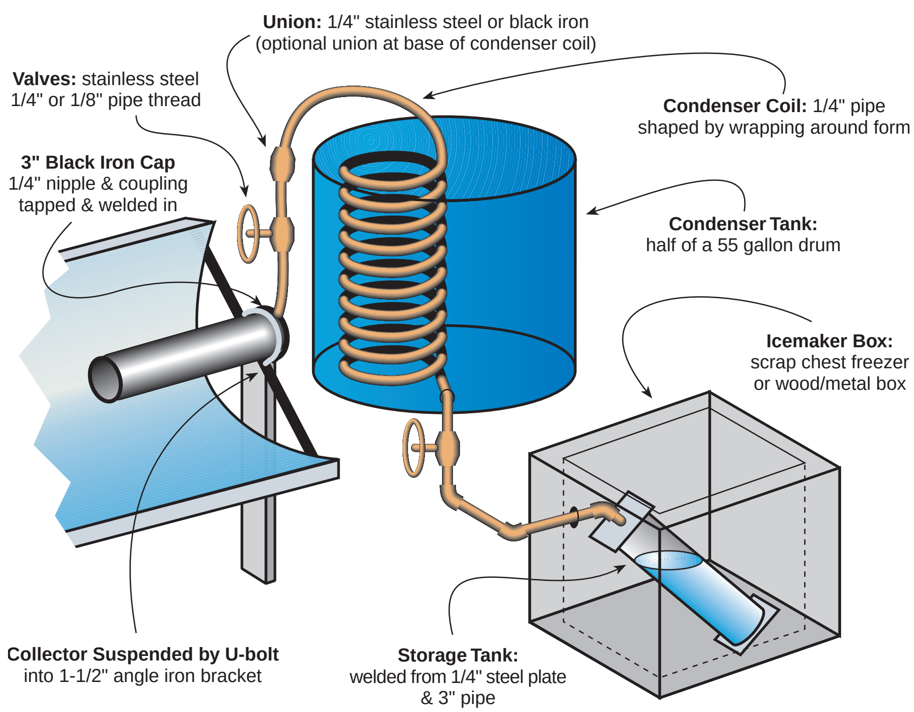
The S.T.E.V.E.N. Solar Icemaker

We call our current design an icemaker. It's not a true refrigerator because the refrigeration happens in intermittent cycles, which fit the cycle of available solar energy from day to night. Intermittent absorption systems can use a salt instead of water as the absorbent material. This has distinct advantages in that the salt doesn't evaporate with the water during heating, a problem encountered with water as the absorber.

Our intermittent absorption solar icemaker uses calcium chloride salt as the absorber and pure ammonia as the refrigerant. These materials are comparatively easy to obtain. Ammonia is available on order from gas suppliers and calcium chloride can be bought in the winter as an ice melter.

The plumbing of the icemaker can be divided into three parts: a generator for heating the salt-ammonia mixture, a condenser coil, and an evaporator, where distilled ammonia collects during generation. Ammonia flows back and forth between the generator and evaporator.

Plumbing Detail **All plumbing is ungalvanized steel (black iron) unless indicated**



Above: Detail of the condenser bath, containing the condenser coil, and the icemaker box below.

The generator is a three-inch non-galvanized steel pipe positioned at the focus of a parabolic trough collector. The generator is oriented east-west, so that only seasonal and not daily tracking of the collector is required. During construction, calcium chloride is placed in the generator, which is then capped closed. Pure (anhydrous) ammonia obtained in a pressurized tank is allowed to evaporate through a valve into the generator and is absorbed by the salt molecules, forming a calcium chloride-ammonia solution ($CaCl_2$ - $8NH_3$).

The generator is connected to a condenser made from a coiled 21 foot length of non-galvanized, quarter-inch pipe (rated at 2000 psi). The coil is immersed in a water bath for cooling. The condenser pipe descends to the evaporator/collecting tank, situated in an insulated box where ice is produced.

Operation

The icemaker operates in a day/night cycle, generating distilled ammonia during the daytime and reabsorbing it at night. Ammonia boils out of the generator as a hot gas at about 200 psi pressure. The gas condenses in the condenser coil and drips down into the storage tank where, ideally, 3/4 of the absorbed ammonia collects by the end of the day (at 250 degrees Fahrenheit, six of the eight ammonia molecules bound to each salt molecule are available).

As the generator cools, the night cycle begins. The calcium chloride reabsorbs ammonia gas, pulling it back through the condenser coil as it evaporates out of the tank in the insulated box. The evaporation of the ammonia removes large quantities of heat from the collector tank and the water surrounding it. How much heat a given refrigerant will absorb depends on its “heat of vaporization,” — the amount of energy required to evaporate a certain amount of that refrigerant. Few materials come close to the heat of vaporization of water. We lucky humans get to use water as our evaporative refrigerant in sweat. Ammonia comes close with a heat of vaporization 3/5 that of water.

Above: About ten pounds of ice are created in one cycle of ammonia evaporation / condensation.

During the night cycle, all of the liquefied ammonia evaporates from the tank. Water in bags around the tank turns to ice. In the morning the ice is removed and replaced with new water for the next cycle. The ice harvesting and water replacement are the only tasks of the operator. The ice can either be sold as a commercial product, or used in a cooler or old-style ice-box refrigerator.

Under good sun, the collector gathers enough energy to complete a generating cycle in far less than a day, about three hours. This allows the icemaker to work well on hazy or partly cloudy days. Once generating has finished, the collector can be covered from the sun. The generator will cool enough to induce the night cycle and start the ice making process during the day.

Solar Ice Maker: Materials and Costs

Quan	*Material*	*Cost*
4	Sheets galvanized metal, 26 ga.	$100
1	3" Black Iron Pipe, 21' length	$75
120	Sq. Ft. Mirror Plastic @$0.50/sq. ft.	$60
2	1/4" Stainless Steel Valves	$50
	Evaporator/Tank (4" pipe)	$40
	Freezer Box (free if scavenged)	$40
1	Sheet 3/4" plywood	$20
6	2x4s, 10 ft long	$20
	Miscellaneous 1/4" plumbing	$20
2	3" caps	$15
1	1/4" Black Iron Pipe, 21' length	$15
4	78" long 1.5" angle iron supports	$15
	Other hardware	$15
15	Lbs. Ammonia @ $1/lb	$15
10	Lbs. Calcium Chloride @ $1/lb	$10
	Total	$510

Future Design

A refrigerator, which is able to absorb heat at any time from its contents, is more convenient than our current intermittent icemaker. To enable constant operation, a future design will include several generator pipes in staggered operation as well as a reservoir for distilled ammonia. Staggered operation will allow the refrigerator to always have one or more of the generators "thirsty" and ready to absorb ammonia, even during the day when generation is simultaneously happening. Generation will constantly replenish the supply of ammonia in the storage reservoir. We are currently in the first stages of making these modifications to the icemaker.

Caution: Safety First!

Working with pure ammonia can be dangerous if safety precautions are not taken. Pure ammonia is poisonous if inhaled in high enough concentrations, causing burning eyes, nose, and throat, blindness, and worse. Since water combines readily with ammonia, a supply of water (garden hose or other) should always be on hand in the event of a large leak. Our current unit is a prototype. We will not place it inside a dwelling until certain of its safety. Unlike some poisonous gases, ammonia has the advantage that the tiniest amount is readily detectable by its strong odor. It doesn't sneak up on you!

For the longevity of the system, materials in contact with ammonia in the icemaker must resist corrosion. Our unit is built with non-galvanized steel plumbing and stainless steel valves, since these two metals are not corroded by ammonia. In addition, during operation the pressure in the system can go over 200 psi. All the plumbing must be able to withstand these pressures without leaks or ruptures.

Would-be solar icemaker builders are cautioned to seek technical assistance when experimenting with ammonia absorption systems.

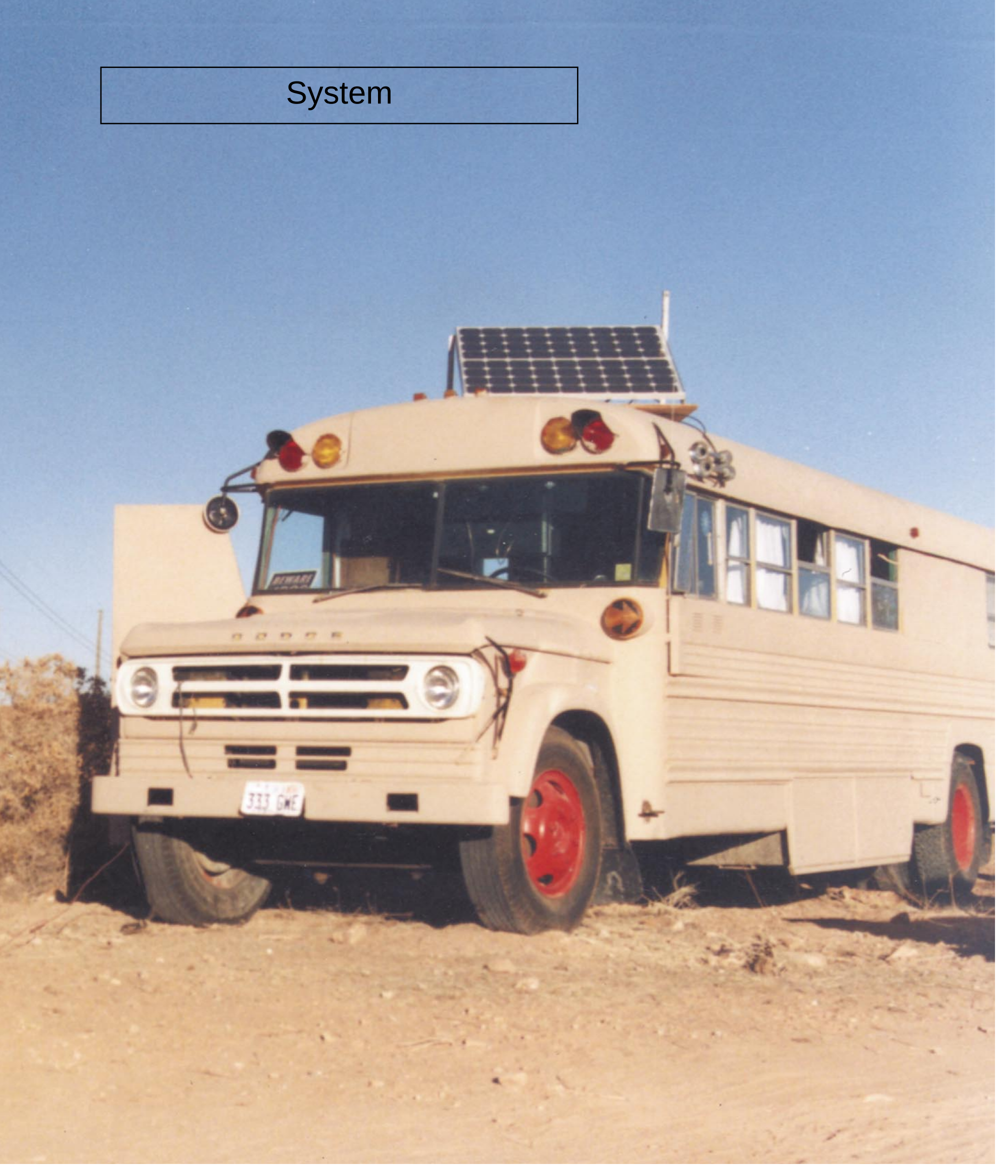
Conclusion

The S.T.E.V.E.N. icemaker has both advantages and disadvantages. On the down side, it's somewhat bulky and non-portable, and requires some special plumbing parts. It requires a poisonous gas, albeit one which is eco- and ozone- friendly in low concentrations, so precautions must be taken. In its favor, it has few moving parts to wear out and is simple to operate. It takes advantage of the natural day/night cycle of solar energy, and eliminates the need for batteries, storing "solar cold" in the form of ice.

Access

Authors: c/o S.T.E.V.E.N. Foundation, 414 Triphammer Rd. Ithaca, NY 14850

SIFAT, Route 1, Box D-14 Lineville, AL 36266



A Solar Cabin on Wheels

Rob Magleby

The desert around Moab, Utah is vast and breathtakingly beautiful. Sunny days are a frequent blessing in this red rock landscape, making southern Utah a choice area for the use of solar modules.

Like many of the residents of this tourist town, I live in a vehicle, a 1970 Dodge school bus. Unlike most, I enjoy the use of power tools, musical equipment, radio and lights thanks to two 85 watt Solavolt modules, an inverter and battery bank. While many people living in buses or motorhomes resort to the use of a generator, the thought of destroying the tranquil silence here with the noise of a generator pains me. After many months of candles and flashlights, I realized that my homemade cabin on wheels would be the perfect test subject for an experiment in solar electricity.

My interest in the project was inspired by the desert itself, where the bright power of the sun is so forcefully felt, even in winter. Keeping in mind my plans to build a more permanent dwelling someday, I began to learn as much as possible about electricity and solar power.

Moab is a town located about two hours from the nearest big city. I soon discovered that I would have to send away by mail for much of the solar equipment. Even items that would be commonplace in some towns, such as wire, were unavailable locally. I collected catalogs, which became my main source of information. Many companies that sell equipment include a lot of information in their catalogs, I was still left with a lot of questions.

From the catalogs I ordered three books which proved extremely helpful in answering questions. Each book covers different aspects of solar electricity. Sources I found the most valuable are listed at the end of this article.

Requirements

My most pressing needs for electricity were night lighting and the use of my radio. I also wanted to run a drill and a skil saw. I did not want to run the battery in my bus so low that it would not start the engine, leaving me stranded at a remote campsite. This fear motivated my use of candles and flashlights to a large extent. The bus has a series of dome lights that light up the whole interior. My use of the interior lights was very frugal. I installed toggle switches in each of the lights so that they could be turned on and off individually. My rule was: no more than one light on at a time, and left on for the minimum amount of time necessary. This strategy worked, as I never did become stranded.

I considered the advice of a fellow desert dweller, who advised me to use two 6 Volt deep cycle batteries in series. This fellow had done so in his van. He claimed that with one or two trips to town a week he was keeping his batteries charged and running lights and radio. I didn't think this was a good set-up for me, as I didn't want to be running the bus engine that much. My lifestyle was centered around driving to a new spot every week or so.

Above: Two Solavolt PV modules tilt and rotate on a homemade frame mounted on the roof of Rob's bus

As I learned more about batteries, I realized that a deep cycle battery was not very appropriate for starting an engine as big as my bus engine. Instead I decided to go with a dual battery system: a separate deep cycle battery for auxiliary use, and a conventional starting battery. My first purchase was a heavy heavy duty starting battery. This battery was more appropriate for starting the big engine than the truck battery I was using. My new battery has higher cold cranking amps and also more reserve capacity. My old battery was recycled by using it in my girlfriend's truck. If I did it over again I would get an isolator switch and use my old battery for an auxiliary battery. This way I would be able to use the radio and interior lights right away with less anxiety.

Below: Rob easily runs his power tools from the PV system in his bus

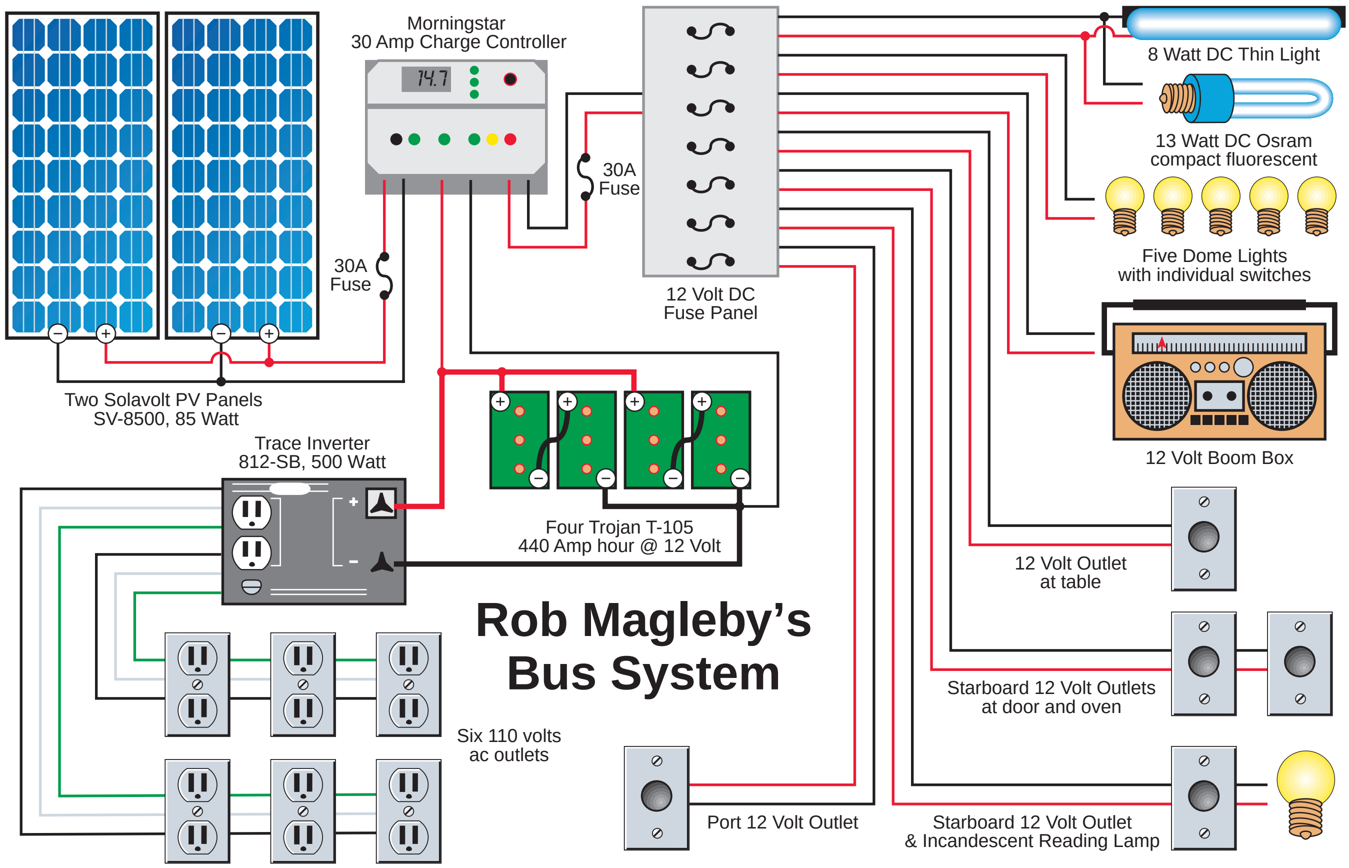
When planning my solar system I was undecided about which kind of lights to use. I wound up trying different kinds to see which provided the best illumination and efficiency. The light that worked the best would be used in my future dream house. I ordered an 8 watt Thin Lite fixture for mounting under the cabinet in my kitchen area, a 13 watt compact fluorescent for general lighting, and an aircraft style 12 VDC incandescent spotlight for my bedroom (I like to read in bed).

To run power tools and other toys, I needed an inverter. I chose the Trace 812SB because of its large surge capacity, two year warranty, and built-in protection features. My only concern with this inverter was the possible interference the modified sine wave might have on my radio reception or the performance of my variable speed drill. I had read of so many different experiences that I didn't know what to expect, so I just crossed my fingers.

I ordered all my equipment through catalogs. The three companies I dealt with were all helpful with planning and ordering over the telephone. All of my equipment arrived within one month and none of it was damaged. The equipment was for the most part represented accurately in the catalogs of these three companies. I recommend all three. My sources are listed at the end of this article.

Batteries

The space available for batteries was pretty limited. I decided to take out the engine-run space heaters in the front of the bus to make space for a battery



compartment. I didn't use the heaters anyway, as my heat and hot water are supplied by a wood and coal fired cookstove. The box that contained the driver's side heater was made into the battery box. The box now has two vents. One vent goes to the outside to allow any battery gases to escape. Another allows heated air from the bus interior to enter the compartment and keep the batteries warm in cold weather. The batteries are accessible through a hinged door in the side and a top that lifts out of the box. (see photo)

I was able to fit four golf cart batteries in the compartment. I chose golf cart batteries because they were recommended in every book I read and by every person I talked to. They were fairly cheap compared to other kinds of deep cycle batteries. Also I figured that since they were made to go into golf carts they could stand up well to the jostling they would receive in my moving bus.

I made my own battery hold down out of angled steel. I used four pieces held together with rivets at the corners to frame the top of the batteries. On two sides I flanged out a flap of metal and drilled a hold through it. I passed a long bolt through this hole and through the floor of the bus. I tightened a nut down on this bolt to hold the frame against the top of the batteries securely.

I series wired the batteries in pairs to give 12 Volts. Then I parallel wired these pairs to give me more amperage capacity. I fused the negative ground of the batteries with a 300 amp catastrophe fuse.

Controller

My charge controller is a Prostar-30. I got a 30 amp controller to allow for expansion of the system later. I attached the controller to a sheet of plywood and mounted this to the wall next to the batteries. Below the controller I mounted my 12 Volt fuse box. Beneath this I mounted 30 amp fuse holders for the load and array. The positive line of each passes through these fuses on the way to the controller. I reserved a spot for the inverter but decided to install it last, after the 12 Volt wiring was finished, because the area was getting cramped, and hard to work in.

12 Volt Wiring

I used #10 duplex wire for the 12 Volt system. I ran the wire down the sides of the bus under a small ledge that once supported the passenger seats. I used anchor bolts to snug the wire up against the underside of the ledge. This worked well. The wiring is easily accessible for future expansion or modification, but it is tidily tucked out of the way and cannot be seen unless you get down on a level with it. Where the wiring ran along

the edges of my wooden cabinetry I used wide staples to hold it flat against the wood.

I wired the two lights on the port side in parallel. I gave each outlet on the port side its own wire run. On the starboard side I wired two of the outlets in series and the rear outlet and light are wired in parallel. I did it this way because I ran short of wire. Each 12 Volt outlet I enclosed in a standard single gang outlet box.

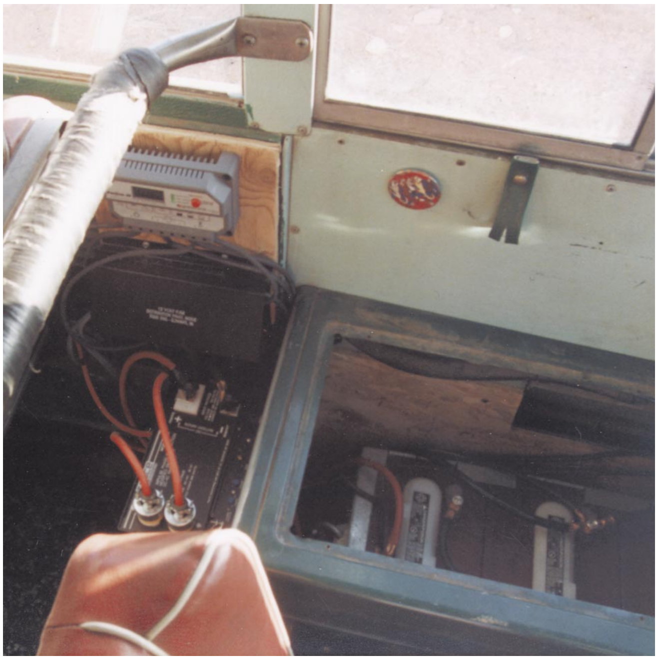
Since the frame of the bus is my ground, it would have been possible to run only a positive line to each place where I wanted to put an outlet or a light, and then grounded each to the frame individually. I decided not to do this because it would have made tracking down a short or malfunction very complicated. Instead I ran all negative grounds back to the battery. This also seemed like a safer way to do it than grounding each light and outlet individually.

Array Installation

In the remote areas where I like to camp, the roads are not always the best. Consequently, I sometimes have to park my bus where the landscape allows. For this reason I wanted to mount my modules in such a way that I could point them towards the sun no matter which way the bus was facing. I invented a mount that rotates.

Above: The four Trojan T-105 batteries ride in a box under Rob's left elbow.

First I attached the two modules together to make one large square shaped unit. I used angled steel with the holes pre-drilled and 1/4" bolts with locking washers. Then I used four small pieces of thick angle steel at the corners to mount the array to a large square sheet of 1" plywood. This arrangement allows the insertion of a leg to point it toward the sun (the leg is another piece of angle steel with holes drilled at different heights for the bolts.) I tested the modules on the ground to make sure they were working properly before lifting them to the roof.



Above: Another view of the charge controller, inverter and batteries nestled to the left of the driver's seat.

The plywood base was mounted to the roof by means of a lazy susan swivel mount in the center of the plywood sheet. Since the roof of the bus is curved, the mount needed support on the outer edges so it would not wobble. I ripped a 2 x 4 down the middle and used the two strips to fill the gap between the plywood and the bus roof at the outer edges. The strips support the mount on each side. (photo)

When I move the bus I remove the legs and put the panels down flat. Then I secure the mount from spinning by putting a couple of screws through the plywood into the side supports. Eventually the wood will wear out and have to be replaced, so this is a temporary mount, but it is effective. I can point the panels right at the sun no matter how my bus is parked.

I used #10 wire to connect the panels in parallel. For the run to the charge controller I used #6 USE with 0-shaped terminal ends crimped on. I ran the wire down the corner of the bus and through the vent and battery box to the controller. The controller only accepts wire of #10 size. Instead of pigtailing a #10 wire onto the end of #6 wire, I just used my wire strippers to trim the ends to #10 diameter, then connected them to the charge controller.

Performance

Since installing the system I have enjoyed the unrestricted use of lights, radio and power tools. I have yet to run the batteries down past the green zone on the meter. Except for keeping an eye on the battery electrolyte and pointing the panels at the sun, there is

no maintenance. Future maintenance will probably involve replacing the wooden array mount and replacing batteries.

Of the different types of lighting I tried, I was most impressed with the compact fluorescent. The light gives a real nice, natural color and there is no flicker or AM interference. Except for the funny shape, it is like a regular incandescent. The Thin-Lite fixture causes AM interference and takes a while to warm up. The fluorescents are much more efficient than my incandescent reading light. I can feel the heat coming from my reading light immediately after switching it on, but the fluorescents run so cool you can put your fingers right on the bulbs.

I use the 120 vac less frequently than I imagined I would, due I think to my good planning of the 12 Volt system. Standard 120 vac is nice to have on occasion. I have encountered some interference on AM radio. The modified sine wave has worked well with my tools, including the variable drill. I have also used it to power TV/VCRs with no interference. The inverter makes the only noise in the system: a small buzz when it is running and a soft ticking when it is in standby mode.

This project sold me on solar completely. Other people are as astonished as I am when they observe my system quietly charging the batteries.

Access

Author: Rob Magleby, PO Box 1398, Moab, UT 84532.

Sources

Hensley Battery and Electrical Supply, Grand Junction, CO • 303-243-6323.

Kansas Wind Power, 13569 214th Rd, Holton, KS 66436 • 913-364-4407 • shipping cost: $4.00 + .50¢/lb.

Solar Electric Inc, 5555 Santa Fe St #J, San Diego, CA 92109 • 800-842-5678 • Ships by UPS.

Energy Outfitters, 136 S Redwood Hwy, PO Box 1888, Cave Junction, OR 97523 • 800-467-6527 • Ships by UPS.

Books

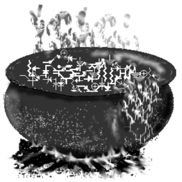
RVers' Guide to Solar Battery Charging by Noel and Barbara Kirkby, Aatec Publications.

The Solar Electric Independent Home Book by Fowler Solar Electric Inc.

The New Solar Electric Home by Joel Davidson, Aatec Publications.

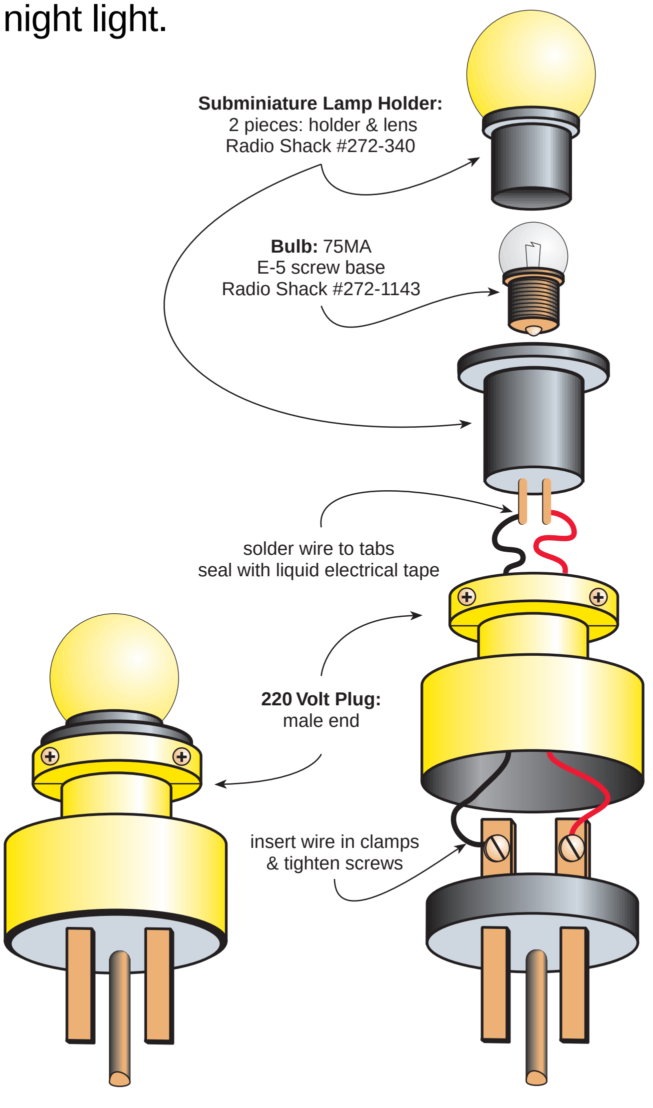

check your
mailing label
Home Power does not send out subscription renewal notices. The last issue of your subscription is printed in plain English on your mailing label. We rely on you to check your label! So check your label and don't miss an issue!

Low Cost 12VDC Night Light



William Raynes

A while back I was asked to recommend a night light for a friend of mine. I started looking through my seemingly endless stack of catalogs to find a suitable choice. I was surprised to find a definite lack of options. About the only light I could find was a pretty costly one, around 60 dollars. Really out of line for a simple night light.



Shopping

The obvious answer was to design a small unit myself, so off to the local electronics store for a look around. At first what I was looking for was a small light to put in a small enclosure, much as the design I had seen in the catalog. After a quick look around, it became clear that the small size of the subminiature lamp holders I found lent themselves to an even more compact design … one that could be incorporated right into the 220 volt plugs we use for low voltage DC service in the homes here on the island.

The shopping list is short. You will need one male plug end of the appropriate type for your particular home. There are many types of plug ends on the market. The thing you need for this application is to be sure that the end that the cord comes thru is adjustable in order to hold the lamp holder securely.

You will need one pack of 12 Volt subminiature lamp holders. The ones I use are Radio Shack part #272-340. They come two to a pack and have both red and white lenses.

You will also need a compatible bulb. This type of holder uses an E-5 base lamp. I used a 12 Volt, 75 mA bulb, Radio Shack part #272-1143. It draws very little power but is quite bright, and will certainly illuminate any room adequately to see your way through it.

Last, you will need a small amount of wire and some liquid electrical tape. I use the liquid electrical tape because the plug end I use has a metal case and I wanted to be sure the wiring inside the plug would not have a chance of shorting out on the case. The only tools you will need are a screwdriver and a soldering iron.

Assembly

Putting the unit together is relatively easy. The only tricky part is the soldering of the lamp holder to the wire. if you are not proficient with a soldering gun, practice a little first since the wire size and spade ends on the holder are quite small. You may want to read HP #18 page 35 on how to solder.

First separate the two halves of the plug end. Cut two lengths of wire just long enough to have room to screw the connectors tight after the wire is passed through the top half and into the lower spade connectors. Now strip both ends of the two wires. It is important to do this now so you will not put any strain on the soldered connections later.

Now solder one end of each wire to the two spade ends coming out of the lamp holders. Loosen the clamping screws on the cord opening of the plug end enough to allow the lamp holder to be inserted. There is a lip on the lamp holder that makes a good depth stop. Put two or three coats of liquid electrical tape on the solder joints and then insert the holder into the plug end up to the rim of the holder. Tighten the clamping screws on the plug half for a secure fit.

There should be just enough wire protruding out the bottom of the top holder to allow the wire to go into the terminals in the lower part of the plug. Put the wire into the two terminals and screw them down. It does not matter which wire goes to which terminal, just be sure not to put any wire on the ground (the rounded, larger prong).

OK, if everything is tight it's time to screw the two halves of the plug back together, making sure the wire is not pinched between them as they come together.

Now all there is to do is put in the bulb and screw on the white lens that came with the holder. There you have it, a perfectly good night light for well under ten dollars. In fact, since most of the components come two to a pack, you can easily make two units like this for under that cost.

Practicality

The original unit I made four years ago is still going strong. The low 75 mA draw of the bulb allows the unit to be left on all night with no substantial drain on the system. I have found it to be a good alternative for any temporary light situation where you would use a low wattage incandescent bulb such as a closet or infrequently used storage area. I think you will be surprised just how much this little light will put out. Once you see what it will do perhaps you will find many more uses for this type of light than I have thought of.

Access

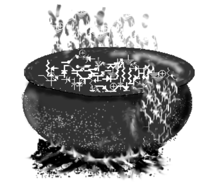
Author: William Raynes, HCO 2 Box 54, Great Spruce Head Island, Sunset, ME 04683

Radio Shack, for the lamps and lamp holder. They're everywhere.

Ace Hardware, for the 220 volt male plug end. They're everywhere, as well.

120 Volt LED Night Light

Robert C. Morris, Jr.



I am an electrical engineer by trade, and have basically dabbled in electronics since childhood. As much as electronics advances daily, I believe in K.I.S.S. (keep it simple, stupid) and try to stay away from bells and whistles while still taking advantage of new devices and technologies as applicable.

This is a solid state night light that I designed and built. It is no technological marvel, but by using high brightness light emitting diodes (LEDs) that seem to get brighter and cheaper, it makes a decent night light. Power consumption is less than 2 watts and it shuts itself off during daylight. It also appears very much as a resistive load to any inverter or other power source. It is very efficient and long living, even when compared to those 4 watt plug-in fluorescent night lights. In fact, I used the case from one of those that burned out to build my light in.

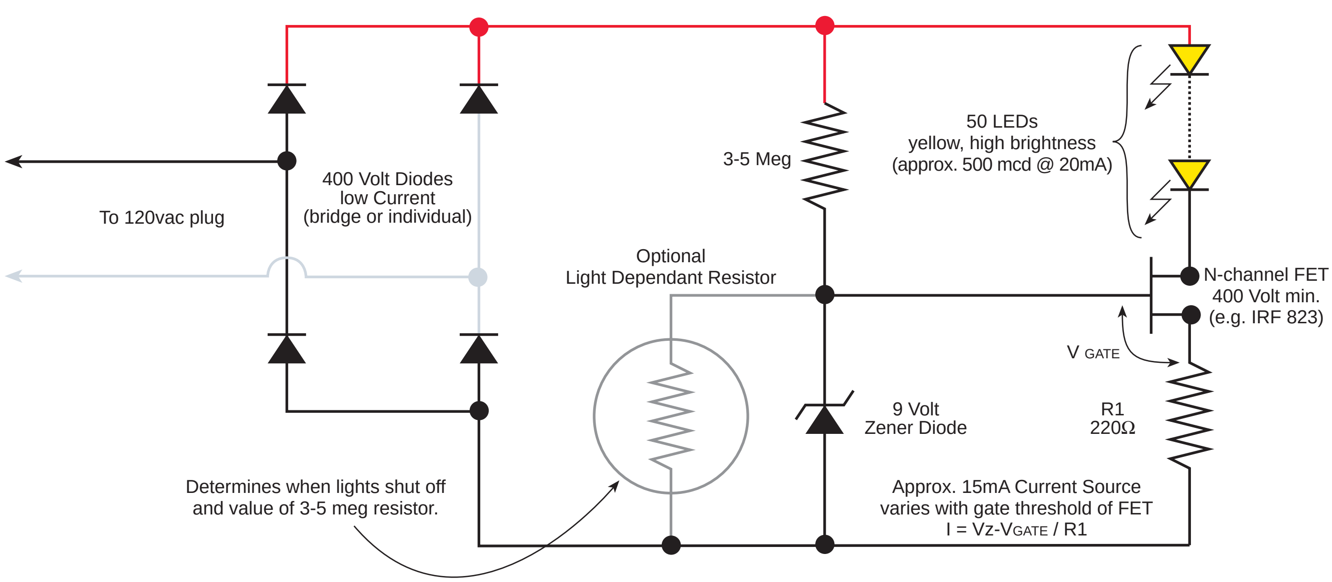
I'm still on the grid but am planning to be off within 2 years. I have always hated leaving night lights on all the time. The incandescent type are basically heaters that happen to give off a fair amount of light. The fluorescent types are much more efficient but still give off some heat and have their lives shortened by daily ON and OFF routine. So, I decided to try an alternative...LED's.

LED's inherently generate virtually no heat under any circumstance of normal use. Their efficiency and brightness seem to improve constantly, as evidenced by their use in automotive brake lights etc. For use for illumination, yellow LED's are the best choice. I found some very high efficiency/brightness yellow LED's from ALL Electronics in CA. I'm sure there are other sources; ALL is the one I happened to use.

An LED requires between 1 and 2 volts DC at 5-50 milliamperes to operate, depending upon the color and particular LED. How to drive them from 120 VAC?

After several failed approachs, I succeeded with the following:

Directly from 120VAC I used a bridge rectifier to generate full-wave rectified DC. It varies between 0 and ~170 volts; 120 times per second. I used a string of 40 LED's in series; which requires ~60 volts to turn on. A resistor could have been used to drop the additional voltage; but would have resulted in a big variation in LED current which is not good for them. It would have also generated a fair amount of heat. It also would not allow an easy way to automatically turn on and shut off. So instead I used an FET in a current sink configuration.



An FET in this configuration wants to sink the amount of current as determined by the component values. It will turn on, off, and "in between" as necessary to cause the proper amount of current to flow. The amount of current it will sink is determined as follows:

$$\textbf{Current sunk} = \frac{\textbf{(Zener voltage - Gate Threshold)}}{\textbf{Resistor value.}}$$

Since FET's are driven by voltage; a very large value resistor to drive the gate can be used. This not only consumes very little current, but allows the addition of a light dependent resistor (LDR) to short the gate to ground and shut the whole thing off during the day. The end result is an automatic night light that uses little power when it's needed, operates automatically day and night, and when it's off it uses practically no power.

Aside from high brightness/efficiency LED's; none of the parts are critical. Diodes (or bridge) and the FET should be 400 V rating or better; and an MOV (150 volt) should be used to protect the FET from line transients. Safety requires a fuse (0.1 ampere is ideal). Even though current is limited through the device; ALL parts are live to line and therefore should be insulated or concealed in the case. I used the case from a fluorescent night light that had died; it is shaped like a dogbone, and has two prongs to plug into AC socket. The LED's I used are clear body and "point source" (focused beam) so be sure to aim them various directions for best illumination. You must restrain the leads at the body of the LED to prevent strain to the actual die of the LED when you are bending them. Of course the polarity of the LED must be observed.

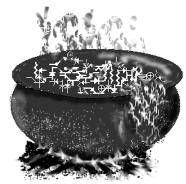
I've built two of these and use them constantly. I measured the power consumption on mine; when ON it draws ≈ 9 milliamps; OFF is less than 0.1 milliamps. The LED's run at about 18 milliamps; but since they are OFF during each part of the line cycle the overall current is about 9 milliamps. So power when ON is not much more than a watt; and consumption when OFF is well below a tenth of a watt. Using a reasonable expected life of 50,000 hours for an LED; and assuming 12 hours ON and OFF each day; one can expect a life for the light at about 12 years. I figure I spent about $10 to build each one; which isn't bad especially when you consider the lifetime and their efficiency. If you have to buy all the parts from scratch it still should cost no more than $20.

I'm working on some other items as well; I'd welcome feedback / questions on my night light.

Access

Author: Robert C. Morris, Jr., 76 Hoyt Rd., Pennellville, NY 13132 • Internet EMail: RobertM934@aol.com

Charging into the Next Century!



Homebrew

Dick Linn

I work for a small family business installing and repairing industrial strength video equipment. It's so small that for years I was the only one in the place with a different last name! They've grown used to UPS delivery of solar panels, windmill blades, etc. showing up at the door for me. Anyway, after working here for 25 years, they decided to give me a "gold watch" for loyalty, dedication, inertia, whatever. Well, instead of a real gold watch they decided on something I could really use, a Bosch 12 Volt cordless drill.

The boss thoroughly researched the field and decided on the Bosch because it's ambidextrous, so a lefty like me could handle it! It came with a charger that warned that it should not be used on generator power, that this could destroy the charger and/or battery. I figured this meant that I better not plug it into my Trace 2024 modified sine wave inverter! No problem.

I had worked up a circuit a couple of years ago to charge the 9.6 V NiCd battery packs in my kids' remote control cars. I just modified this and used it for my drill battery packs. I've been using it for the drill for a year and with the R/C cars for 3 years with no problems.

Here's the Scoop

The basic idea came from Richard Perez in HP#5. He called it the "Pulsar". It uses pulses to charge NiCds which is very healthy for them as it removes the dendrites within before they become harmful. I added a timer circuit to this design to turn off the charger automatically.

The timing half of the circuit uses a 4541 counter chip and 1/2 of a 556 timer chip. The 556 is just two 555 timers in one package. One half of the 556 is used as a low frequency oscillator to drive the 4541 counter. The other half is the source of high frequencies to drive the actual pulsar charging circuit. The 4541 has an on-board oscillator but I was not able to get it to operate at the low frequencies that are needed for this circuit. So it is disabled.

The values given will run the timing oscillator at about 10 Hz. This will run the charger for about 109 minutes giving about a 50% overcharge. Then the green LED comes on and the charger stops charging. The LEDs stay lit but your battery isn't being charged. This way, if you're forgetful, your battery isn't being cooked. To reset and charge another battery, just unplug the charger and plug it in again.

The second half of the 556 timer is an oscillator that runs at about 200 Hz. This drives two LM317s in parallel through a transistor. The 317s are what actually supply current to the battery.

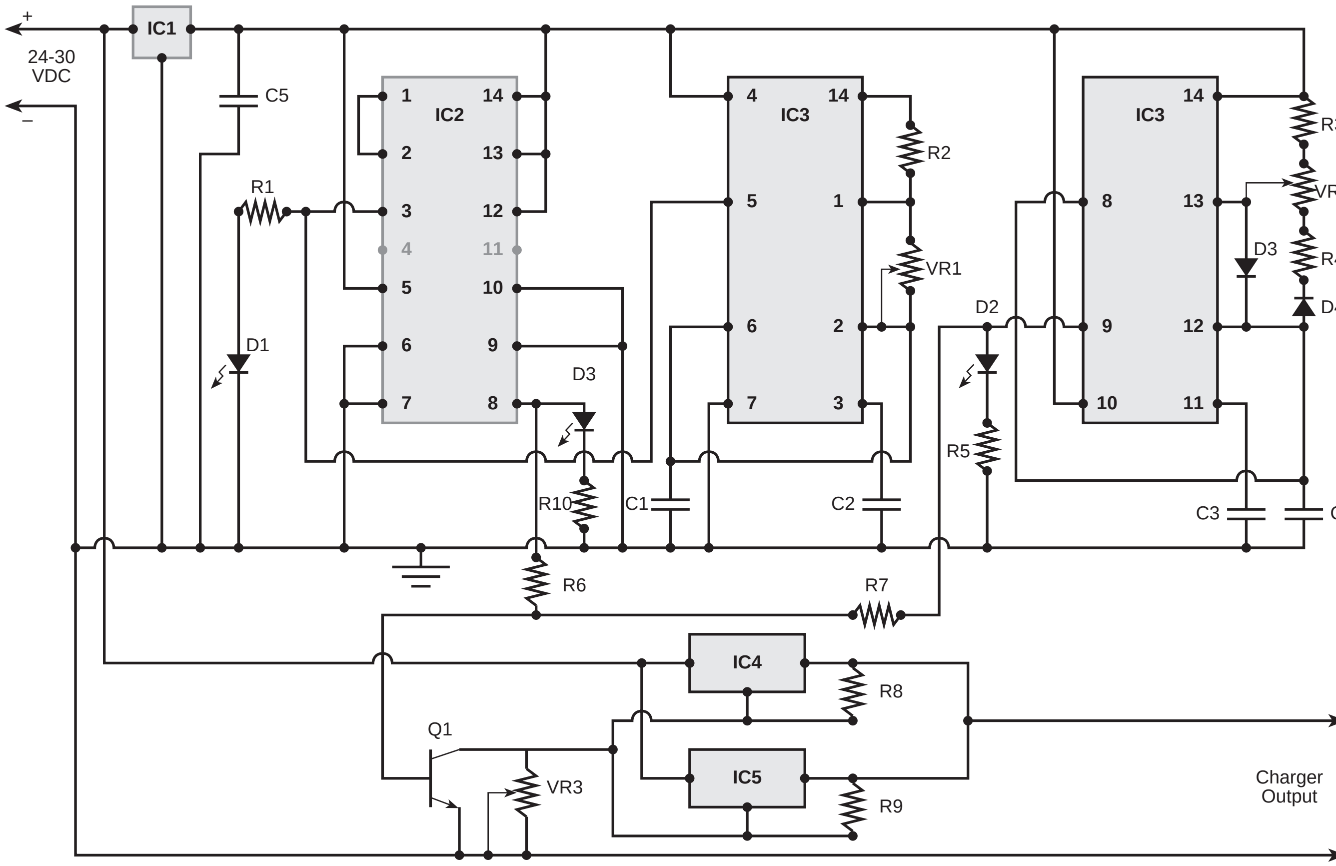
To setup the charger for use, set VR1 to about its midpoint to set the oscillator at about 10 Hz. Set VR2 at its midpoint, giving a 50% duty cycle to the charging pulses. Set VR3 to about 3.1 kΩ. This gives an output voltage of about 16.5 VDC. At least it did on mine. For a 10 cell, 12 Volt (nominal) NiCd, this will give a final voltage of 1.65 per cell. Just right. If you are using a different voltage battery, do the math and set your output voltage accordingly. At this point fine tune the output current for your cells' Ah rating. Most battery powered drills are "C" sized cells so 2 amps is a good number to start at.

The LEDs

According to Richard's article on the original "Pulsar" it's best to set the voltage as high as possible and adjust the current with the duty cycle control. I'm sure he's right, I've just had good luck with these settings. You can use LED D2 as a guide to duty cycle as it is driven by the pulse output. It gets brighter as the duty cycle increases.

LED D1 flashes at the rate of the slow speed oscillator driving the counter. It will flash at about 10 Hz. I use a red one as the power on indicator, but suit yourself. LED D3 comes on when the charger turns off. I used green for this one.

I used a Radio Shack project box to house the PC board and screwed this to the side of the surplus heat sink I used for the regulators. I also mounted a small 12 VDC fan to the heat sink to keep the temperature down. This gets its power from the regulated 9 VDC that feeds the ICs.



Parts List:

IC1	7809 9 Volt regulator	VR1	5 kΩ	D1, D2	Red LED
IC2	CD4541 timer	VR2	50 kΩ	D3, D4	1N914
IC3	556 timer	VR3	10 kΩ	D5	1N5401
IC4, IC5	LM317T voltage reg.	C1	100 µf@ 35 VDC	D6	Green LED
R1, R5, R6	1 kΩ	C2, C3	.05 µf@ 25 VDC	PC Board	276-150 (Radio Shack)
R7, R10	1 kΩ	C4	.01 µf@ 25 VDC	Heat sink	Good sized,
				Fan	Optional, depends on heat sink

Notes of Caution

Be sure that the cells you want to charge can take a fast charge before using this charger, you can cook regular NiCds if you try to fast charge them. Coupling two LM317s in parallel as I have done is not the usual recommended procedure. However, I have used this technique successfully for several years in several circuits besides these chargers. The devices seem to run at about equal temperatures, which indicates to me that they are sharing the output load. I suspect that their internal protection circuitry aids in this balancing act. Whatever, it works and is cheaper than buying the more expensive LM350 regulator.

While I designed this charger to use on my 24 VDC house system, sourced by a home built windmill and a bunch of used solar panels, you could probably modify it for use with inverters by adding a plain vanilla power supply in front of it. You know, a transformer, bridge rectifier and a filter cap. It wouldn't have to be fancy to do the job. I've used the circuit a couple of times this way and it works fine. Also, it should work directly from a solar panel as most of the 36 cell ones output in the neighborhood of 17-18 volts. This would probably give enough extra voltage to charge a 12 Volt NiCd pack and for sure charge the 9.6 Volt packs that some drills use. You could adjust the pulse width and voltage controls to optimize for the output of the solar panel.

Related Uses

Some of the other variants of this charger have been put to use charging "AA" NiCds for my brother's Walkman and, of course, the kids' remote control cars, whose battery packs are made up of "AA" NiCds @ 9.6 volts. I made a 120 vac version of the R/C car charger for my nephew after he came to visit with his R/C car and it wouldn't keep up (charge wise) with my boys' cars.

I also use the timer part of the circuit to turn on my water pump once an hour for 5 minutes. We have a slow-recovery drilled well and this keeps the water running smoothly. (We store water in tanks that gravity feed the house.)

For the water pump circuit, I tied pin 10 of the 4541 to Vcc. This puts the timer in the “recycle” or continuous mode. It then counts off the hours and fires another 555 timer set to cycle for 5 minutes. This turns on a 740 MOSFET that pulls the heavy duty relay powering the water pump.

Have fun with the circuit, and if you’re as absentminded as me it may even keep you from frying some NiCds! For those of you who might be interested in trying other projects with the 5451, here are some more details. It actually counts down via two 8 stage counters. By changing whether pins 12 and 13 are at ground or Vcc, you can vary the count. Refer to the following table:

Pin 1	Pin 13	# of counter stages (n)	Count (2^n)
0	0	13	8192
0	1	10	1024
1	0	8	256
1	1	16	65536

Find a data sheet if you need more info on this chip. I have fun with it.

I picked up all my parts from Rad-Tronics, a small local electronics supplier that handles new and surplus parts quite reasonably. However, all the parts are also available from DigiKey, except the PC board and project box which came from Radio Shack.

I just got a catalogue from a mail order place that has a heat sink similar to the one I used for $6.95. It’s about 5 1/2 inches by 4 inches by 2 1/2 inches. The catalogue is from a place called M.P. Jones Assoc. Inc. They also have a variety of fans.

Access

Author: Dick Linn, 3771 Morgan Road, Interlaken, NY 14847 • 607-532-9517 • Internet: DickMLinnn@aol.com

Component Sources:

Rad-Tronics, 1005 N. Cayuga St. Ithaca, NY 14850 • 607-273-8026

Digikey, Thief River Falls, MN 56701 • 800-344-4539

Radio Shack, They’re everywhere

M.P. Jones Assoc. PO Box 12685 Lake Park, FL 33403 • 800-652-6733 (minimum order $15.00)

PHOTOCOMM

full page

Black and White

on negative

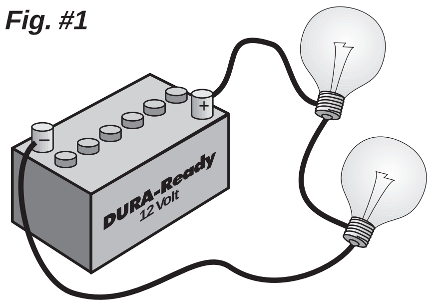
this is page 37

Series, Parallel, & Combination Circuits

Benjamin Root

The best way to get a grip on what is actually happening in any electrical circuit is to understand the relationships between Volts, Amps, and Ohms in Ohm's law. Let's explore how these relationships change depending on the layout of the circuit and its components.

Fig. #1

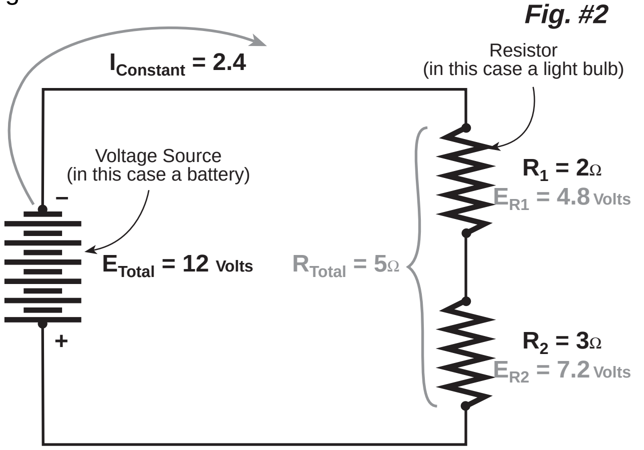


Series

A circuit is considered to be "in series" when all components are connected in such a way that there is only one possible path for current to flow. This means that each voltage source, switch, load, or other component is in succession with the other components of the circuit. Electrons flowing through such a circuit flow through every component in turn. Figure #1 shows a pictorial representation of a simple series circuit with a battery voltage source and two light bulbs as loads. Figure #2 shows a schematic representation of the same circuit. If you trace the path of an electron as it flows from the negative terminal of the battery through the circuit to the positive terminal you will notice that it passes through one lightbulb (R_1) before it passes through the other lightbulb (R_2). There is no way for an electron to pass through bulb 2 (R_2) first, nor is there any way for an electron to pass through one bulb but not the other. The electron flow (current) follows the one and only path through the circuit.

You may remember Christmas tree lights of the past. When one bulb burned out (creating an open circuit) all of the bulbs would turn off. This is because the burned out bulb had interrupted the current flow in the only current path. With no current in the circuit no bulbs will light.

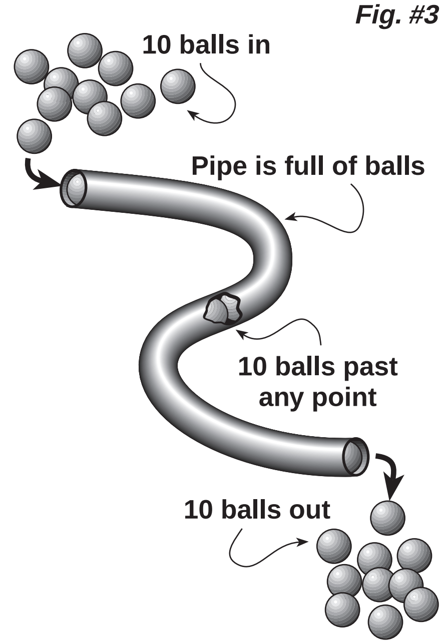
Fig. #2



Current in a Series Circuit

In 1847 a German physicist named Gustav Kirchhoff made a statement about the behavior of electrons in a circuit. "Kirchhoff's law" says that for every electron that enters a circuit another electron leaves the circuit. We can model this concept if we imagine a pipe with a diameter just big enough to accept a golf ball (see figure #3). If we fill this pipe with golf balls we have a model of a copper wire where golf balls represent electrons of copper atoms. If we push a new golf ball into one end of the pipe a golf ball will fall out of the other end of the pipe. If we push ten golf balls into the pipe in one minute, then ten golf balls will fall out of the other end in that minute. If we drilled a little hole anywhere in the pipe, just big enough to peek in, we would count ten golf balls going by that point in one minute. Ten golf balls a minute is a rate in the same way that 6.28 X 10^{18} electrons in a second (one amp of current) is a rate.

Fig. #3



In a series circuit, just like in the pipe, current flow is the same throughout the circuit. No matter how many loads, in any order, current will be consistent everywhere. Knowing the amperage of a series circuit makes it easier to use Ohm's law to analyse that circuit.

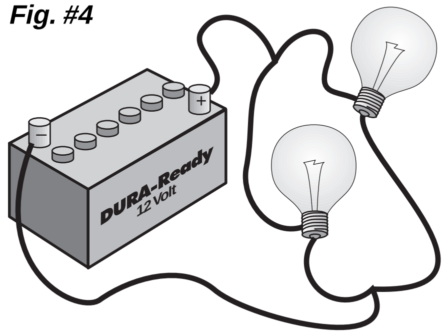
Resistance in a Series Circuit

The total resistance of a series circuit is merely the sum of all the individual resistances.

$$R_T = R_1 + R_2 + R_3 ... R_x$$

This is easy, the total resistance (R_T) of the circuit in figure#2 is the sum of R_1 + R_2 or 5Ω. The formula holds true for resistors of any value as long as they are in a series string. R_T is a valuable component for applying Ohm's law to the circuit as a whole.

Fig. #4



Voltage in a Series Circuit

The Voltage of a series circuit is a bit trickier to determine than Amperage or resistance. The total Voltage (E_T) of a circuit can be figured using Ohm's law.

$$E_T = I \times R_T$$

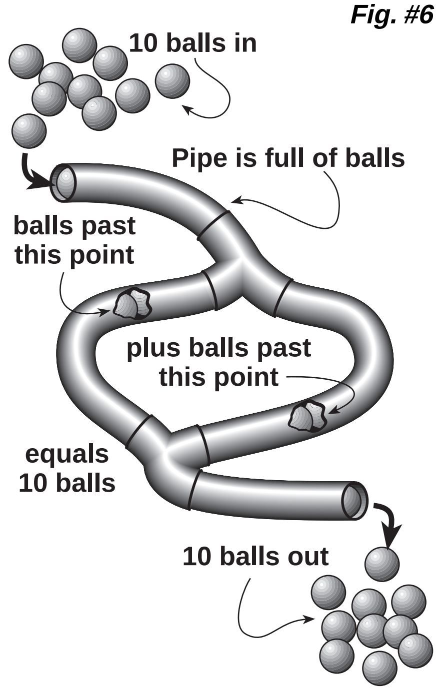
Unlike amperage however, voltage is not the same throughout the circuit. E_T is the voltage as it is measured across the two terminals of the voltage source, including the whole circuit and all resistors. The voltage measured across any single resistor varies with the size of the resistance. Look again at Figure #2. If we use Ohm's law to solve for voltage across R_1 we get 4.8V (E_{R1} = 2.4A X 2Ω). This 4.8V is called a voltage drop because it reduces the voltage available in the rest of the circuit. Lets continue by solving for voltage across R2. E_{R2} = 2.4A X 3Ω; the voltage drop across R2 is 7.2V. This makes sense, as you may have noticed, the sum of the voltage drops equals the total applied voltage.

$$E_T = E_{R1} + E_{R2} + E_{R3} ... E_{RX}$$

Series in Summary

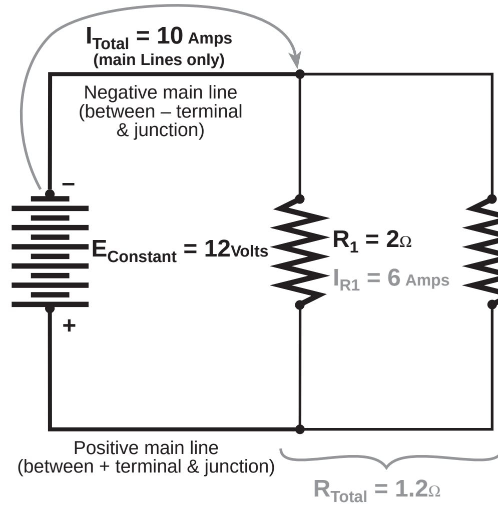
A series circuit is a linear arrangement of components with only one possible current path. Current is constant throughout a series circuit. Total resistance in a series circuit is the sum of the individual resistances. While voltage varies throughout a series circuit, the sum of the voltage drops across the individual resistances is the total voltage (applied voltage).

Fig. #6



While series relationships are common in micro electronics they are rather rare in typical home wiring. Switches are wired in series with the load that they control and fuses are wired in series with the circuit that they protect. But loads themselves are usually wired in parallel for the same reasons that Christmas lights are no longer made in series. See the side bar on voltage sources for an example of a use for series wiring in renewable energy systems.

Fig. #5



Parallel Circuits

A circuit is parallel when each of its components has its own current path from, and to, the voltage source. An electron travelling from the negative terminal of the voltage source need only pass through one component before reaching the positive terminal. Although components may share the same "main line" wiring to and from the voltage source, there may not be another component in series. See figures #4 and #5. Imagine a ladder with a battery on the first rung. The left side pole is the positive main line and the right side pole is the negative main line. In a parallel circuit all the components fall on rungs of the ladder. Basically, each component is wired directly (and individually) to the positive and negative terminals of the battery.

The way that voltage, amperage, and resistance interact within a parallel circuit differs greatly from series circuits.

Voltage in a Parallel Circuit

Voltage is a constant throughout a parallel circuit. This makes sense because each component is individually connected to the terminals of the voltage source. Each component is experiencing the entire applied voltage and is not effected by other components in the circuit.

Current in a Parallel Circuit

Current is the varying factor in a parallel circuit. Each branch has its own amount of current flow based on the resistance of that branch. Look at figure #5 for example, we can simply apply Ohm's law to solve for Current through the parallel branch containing R_1. $I_{R1} = E / R_1$, or I_{R1} is 6 Amps. Using the same process we can solve I_{R2} as 4 Amps.

It is important to note that the main line portion of the circuit is carrying current for both branch circuits. The current in this part of the circuit is the sum of the currents in the branch circuits.

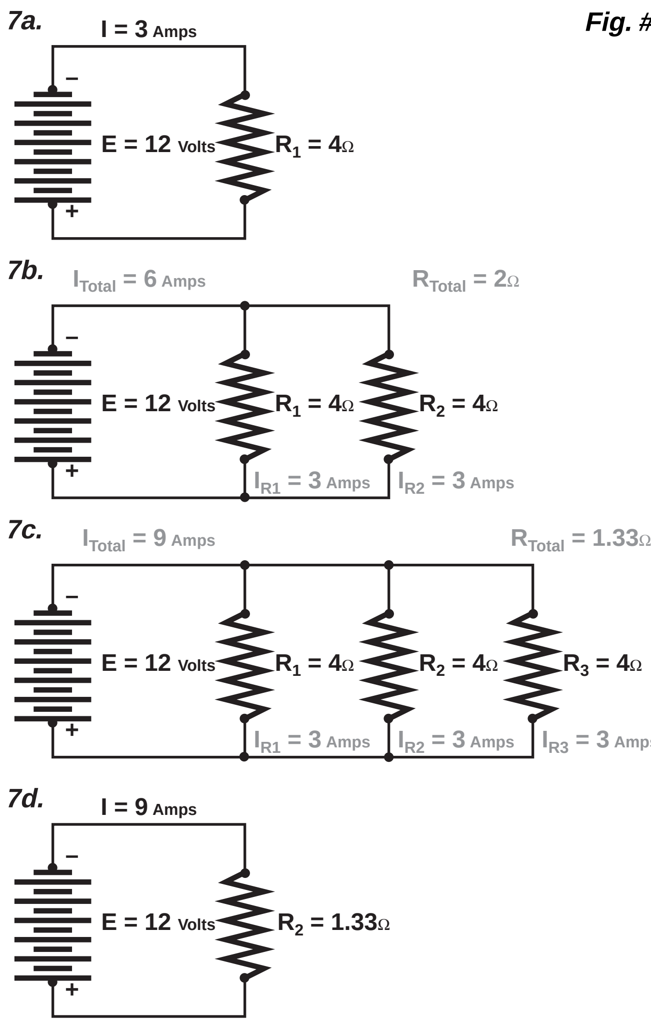
$$I_T = I_{R1} + I_{R2} + I_{R3} \ldots I_{RX}$$

In the example shown in figure #5 the current in the main lines is 10 Amps. Lets go back to our model of the pipe full of golf balls, figure #6. This time imagine the pipe splitting into two branches for a while then joining again before ending. Imagine we look through a little peep hole in one branch and notice 6 balls passing us in a minute, and we see 4 balls passing a point in the other branch, we know that 10 ball must be entering the single entrance to the pipe and that 10 balls must be falling out the exit end of the pipe in that same minute. Kirchhoff's law applies to parallel circuits too.

Resistance in a Parallel Circuit

When using Ohm's law to solve for total resistance ($R_T = E/I_T$) we will notice something interesting. The total resistance of a parallel circuit is less than the smallest single resistor in that circuit. Notice figure #5 again: 12 Volts / 10Amps = 1.2Ω. A total resistance of 1.2Ω for the whole circuit is less than either single resistor (R_1=2Ω or R_2=3Ω). How can the adding of resistors to a parallel circuit actually lower the total resistance? Current is the cause. Each new resistor that is added in parallel to a circuit increases the total current in that circuit; remember the formula for I_T. Resistance (R) is equal to voltage (E) divided by total current (I_T). With voltage remaining constant, as total current increases then resistance must decrease. Take a look at figure #7, it shows how total resistance changes as new resistance is added in parallel. Figure #7d shows a circuit with a single resistor equivalent to the total resistance of the circuit in figure #7c.

Fig. #7



There are several formulas for solving total resistance given only the individual resistances. Some of these formula work only for special cases. One formula which will always work is called the "Reciprocal Resistance Formula." This formula is based on substituting E/R in the place of I in the formula for total current.

$$E/R_T = E/R_1 + E/R_2 + E/R_3 \ldots E/R_X$$

We can divide by E, because voltage is constant, which changes the formula to

$$1/R_T = 1/R_1 + 1/R_2 + 1/R_3 \ldots 1/R_X$$

If we use this formula to solve RT for the circuit in figure #7c we get

$$1/R_T = 1/4 + 1/4 + 1/4$$

$$1/R_T = 3/4$$

$$R_T = 4/3 \text{ or } 1.33\Omega$$

This formula will work for any number of resistances in parallel even if they are not all the same.

Parallel in Summary

In a parallel circuit each component is, in effect, connected directly to the terminals of the voltage source. This means that voltage is the same throughout the circuit because to measure across any component is the same as measuring across the main voltage source.

Each component has its own current path independent, except for shared main lines, from the other components in the circuit. Current flow through any component is the product of voltage divided by the resistance of that component. The total current of the circuit, through the main lines, is the sum of the currents through the individual branches.

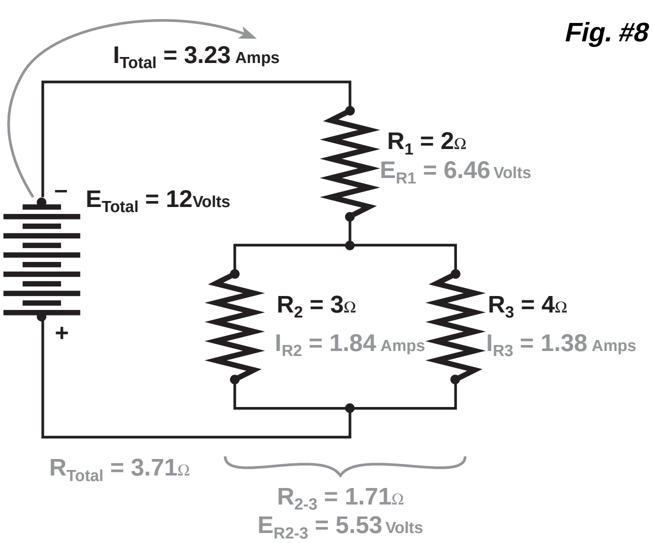
The total resistance in a parallel circuit is less than the value of the smallest resistor. This value can be solved using the reciprocal resistance formula which is based on the inverse relationship between resistance and current.

Parallel relationships are much more common than series for components in home wiring systems. Parallel loads, like the lights and outlets in your home, function independantly from each other. This is good, we don't want the other lights to dim when we turn one more light on. Parallel wiring provides a consistant voltage supply to every load we choose to use.

Combination Series Parallel Circuits

Circuits need not be strictly series or parallel in configuration. In electronics it is common for circuits to have both series and parallel elements. The behavior of voltage, current, and resistance in these series-parallel circuits can be a confusing combination of all the rules that we have already discussed. The best technique for analyzing a series-parallel circuit is to break it down into its fundamental parts.

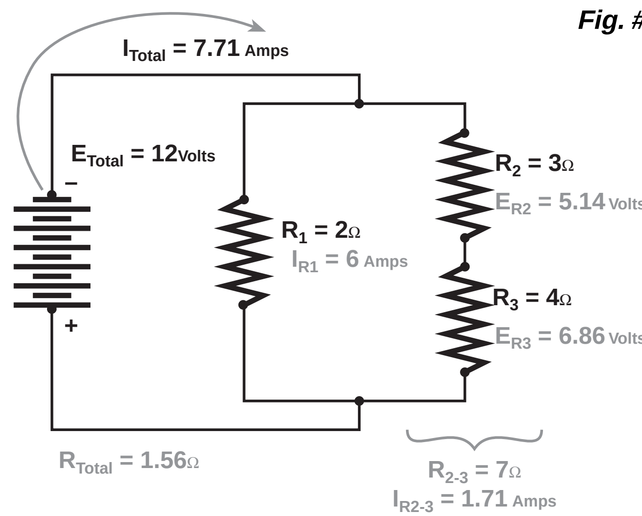
Fig. #8



In figure #8 the overall circuit is a series string starting with R_1. Where we would next expect R_2 instead is a parallel bank containing branches R_2 and R_3. To determine R_T for this circuit we must first evaluate the resistance of the parallel bank. By using the reciprocal resistance formula we determine the resistance of $R_{2\text{-}3}$ to be 1.71Ω.

$$\mathbf{1/R_{2\text{-}3} = 1/R_2 + 1/R_3}$$
$$\mathbf{1/R_T = 1/3\Omega + 1/4\Omega}$$
$$\mathbf{1/R_T = 4/12\Omega + 3/12\Omega = 7/12\Omega}$$
$$\mathbf{R_T = 12/7\Omega = 1.71\Omega}$$

Fig. #9



Only now can we use the series technique of adding resistances to determine total resistance.

$$\mathbf{R_T = R_1 + R_{2\text{-}3}}$$
$$\mathbf{R_T = 2\Omega + 1.71\Omega}$$
$$\mathbf{R_T = 3.71\Omega}$$

Now lets look at another series-parallel circuit. Figure #9 also has three resistors but this time the overall circuit is a parallel bank. While one branch contains R_1 the other parallel branch contains a series string of R_2 and R_3. When solving for R_T we must first determine the resistance of the series string $R_{2\text{-}3}$.

$$\mathbf{R_{2\text{-}3} = R_2 + R_3}$$
$$\mathbf{R_{2\text{-}3} = 3\Omega + 4\Omega}$$
$$\mathbf{R_{2\text{-}3} = 7\Omega}$$

Now can we use the reciprocal resistance formula to solve for R_T.

$$\mathbf{1/R_T = 1/R_1 + 1/R_{2\text{-}3}}$$
$$\mathbf{1/R_T = 1/2\Omega + 1/7\Omega}$$
$$\mathbf{1/R_T = 7/14\Omega + 2/14\Omega = 9/14\Omega}$$
$$\mathbf{R_T = 14/9\Omega = 1.56\Omega}$$

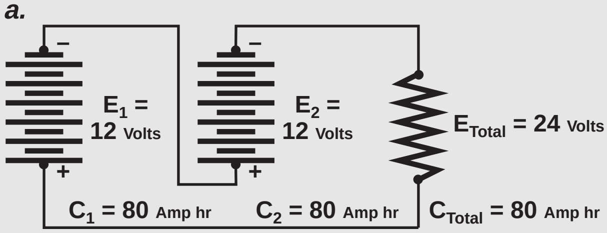
Obviously series-parallel circuits can be much more complex than the examples examined here. Fortunately, the techniques for evaluating them are the same. The trick is to break the circuit down into basic series or parallel relationships, then rebuild these individual parts to evaluate the circuit as a whole.

Series & Parallel Voltage Sources

Ohm's law and how it interacts in series and parallel circuits pertains to voltage sources too. Batteries and photovoltaic modules can be wired together in various ways to provide a desired output voltage. The rules for series and parallel hold true, the only difference is that positive and negative polarity are important.

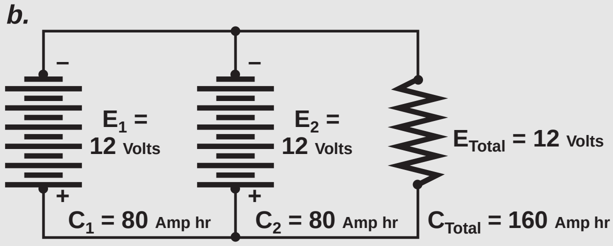
In example "a" below are two batteries wired in series (+ to –). The applied voltages of each battery add together to create a total circuit voltage. This coralates to the way that voltage drops across series resistors add up to the total circuit voltage. The capacity (C) in amp-hours coralates to the way current (I) in amps is constant throughout a series circuit.

a.



In example "b" two batteries are wired in parallel (+ to +, – to –). Adding voltage sources in parallel does not change the total circuit voltage. This relates to how adding resistors in parallel has no effect on circuit voltage. In parallel the amp hour-capacity is the sum of the capacities of the individual voltage sources.

b.



Of course batteries (and PV modules) can be wired in series-parallel configurations to provide varying voltage supplies and amp-hour capacities. This modular flexability is important to meeting the varying demands of renewable energy systems.

Summary

The behavior of electricity in series, parallel and series-parallel circuits is a product of Ohm's law relationships between voltage, current, and resistance. While independent parts of the circuit interact differently depending on their series or parallel relationships, the circuit as a whole adheres strictly to Ohm's law. These relationships hold true for both ac and DC electricity. Whether studying micro electronics, 12 Volt DC renewable energy systems, or 240 volt ac systems from the utility grid, Ohm's law and the guidelines for series and parallel are common building blocks.

Access

Author: Benjamin M. Root, C/O Home Power, PO Box 520, Ashland, OR 97520 • 916-475-3179 • ben.root@homepower.org

Basics of Alternating Current Electricity

Part Two—Phase and Power

Richard Perez

This series of basic electric articles continues with a discussion of power in alternating current circuits. Learn why powering loads such as motors and electronics is difficult for inverters and generators.

In the first article in this series (Home Power #52, page 74), we discussed the repetitive and sinusoidal nature alternating current electricity. We got a hold of the concepts of amplitude, frequency, period, and phase in sinusoidal waveforms. If you missed this article, or if the concepts have grown fuzzy during the last two months, then give Part One of this series a read. You will need the concepts presented there to understand what you will read here.

Phase

The concept of phase is essential to understanding alternating current electricity. Phase means time, or more specifically a time interval between when one repetitive thing happens and another repetitive thing happens. In the case of alternating current electricity, we are talking about the time when maxima and minima happen on sinusoidal voltage and current waveforms. An event which happens after a related event is said to lag. An event which precedes a second and related event is said to lead. The preferred unit for phase is degrees as in 360° in a circle or a single cycle. This unit of measurement works well because of the repetitive nature of sinusoidal alternating current electricity.

Voltage and Current in Resistive Loads

In a resistive load, such as an electric heater or an incandescent lightbulb, the voltage and current waveforms are always exactly in phase. Figure 1 illustrates the voltage and current waveforms powering a 1000 watt electric heater. Note that the voltage and current waveforms reach maxima, minima, and zero at exactly the same instant. This is the definition of “in phase”. Note that the current waveform varies from zero to a positive peak of 12 Amperes and a negative peak of -12 Amperes. These peaks in current are called exactly that—peak current.

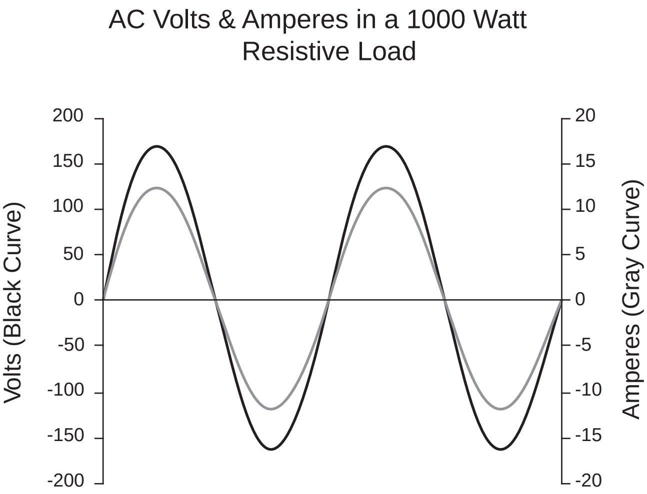


Figure 1

Voltage and Current in Inductive Loads

Not all electric loads are resistive like the heater and the lightbulb. Some appliances convert the alternating current electricity into magnetic fields rather than heat. These appliances include electric motors, and any device that uses a transformer to convert power from one voltage to another. The list of appliances which convert the electric power into magnetism for whatever reason is very long: well pumps, table saws, coffee grinders, microwave ovens, TV sets, VCRs, and in fact, most of the appliances we wish to power in our systems. All appliances that primarily convert electric power into magnetism are known as “inductive” loads. Alternating current electricity is converted into magnetism by a process called electromagnetic induction, hence all the appliances that use this effect are called inductive loads.

In the conversion from electric power into magnetism, a strange thing happens to the electric power—voltage and current become out of phase. Instead of being in phase with voltage, the current lags behind the voltage—the current waveform is delayed in relation to the voltage waveform.

Figure 2 shows the operation of a 1000 watt electric motor. Note that the voltage and current waveforms are no longer in phase. The current waveform lags some 45 degrees behind the voltage waveform. Another thing to notice is that, in order to deliver 1000 watts of power to the inductive load, the current peaks must increase to 17 amperes. More on why this happens when we shortly discuss power in inductive circuits.

Voltage and Current in Capacitive Loads

Some appliances convert alternating current electricity into electrostatic fields. These appliances include anything with the new “switching” power supplies which

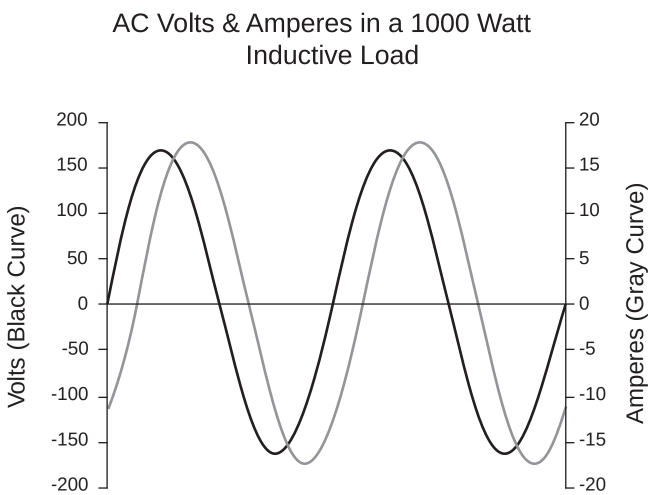


Figure 2

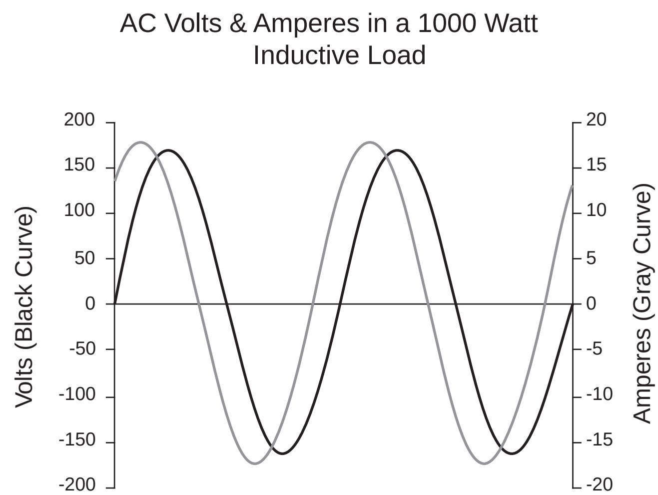


Figure 3

convert 120 vac into other (usually DC) voltages, Switching power supplies are used in most compact fluorescent lights, computer power supplies, and some battery chargers. These loads behave like capacitors and are know as capacitive loads. While not as common as inductive loads, the average household uses many of these capacitive loads.

Changing alternating current electricity into an electrostatic field changes the phase relationship between the voltage and current waveforms. The situation is similar to inductive loads, only the effect is the exact opposite. The voltage waveform seems to lag behind the current waveform. Figure 3 shows shows the operation of a 1000 Watt capacitive load. Note that the voltage waveform is now lagging behind the current waveform.

Reactive Loads

The effect of either an inductive or a capacitive loads is to make the voltage and current waveforms go out of phase with each other. This effect is called reactance. As we will see when we shortly discuss power in alternating current circuits, reactance is a form of resistance that is particular to alternating current devices which are not purely resistive (i.e. the loads are either inductive or capacitive). What I have illustrated here is really an ideal look at inductive and capacitive loads. Actually all reactive loads also have resistance and the real world situation is even more complicated than shown here.

One characteristic of both inductive and capacitive loads is that they are able to store power. The inductive load stores power in its magnetic field. The capacitive load stores power in its electrostatic field. At certain instants of time, the power stored in the reactive load may be greater the power being supplied by the alternating current electricity. At this point the load actually shoves energy back at the ac power source. Hence the idea of reactance being a form of alternating current resistance not present in direct current circuits.

Power in Resistive Circuits

Power is calculated much the same way in resistive alternating current circuits as in direct current circuits. Power (Watts) equals volts times amperes (P=EI). The only problem is that in ac power voltage and current are constantly changing amplitude and polarity. If at any instant we multiply volts times amperes, we will get the power at that instant. If we were to do this for an entire cycle of the sine wave, then we could accurately measure the amount of energy delivered to the load by that sine wave. This process (known as arithmetic integration) is best illustrated by a graph.

In Figure 4 the heavy black curve represents the ac voltage. The gray line close to the time (horizontal) axis represents current, in this case a 1000 Watt resistive load like the one shown in Figure 1. The dashed line curve is volts (at any instant) multiplied by current (at that same instant)—in other words, power. The area between this power curve and the horizontal axis represents the energy delivered by the alternating current electric power to the load. Note that the entire power sine waveform is in phase with the voltage and current waveforms. Note that the entire power waveform is positive and above the x-axis (time). All is well, power transfer in the circuit is 100%. There are no reactive components to the load, it simply sucks up all the power that the ac waveforms can deliver. Since this is an alternating current circuit, the amount of power consumed by the load is constantly changing. For a 1000 Watt resistive load the power delivered varies from zero to a peak of 2000 Watts.

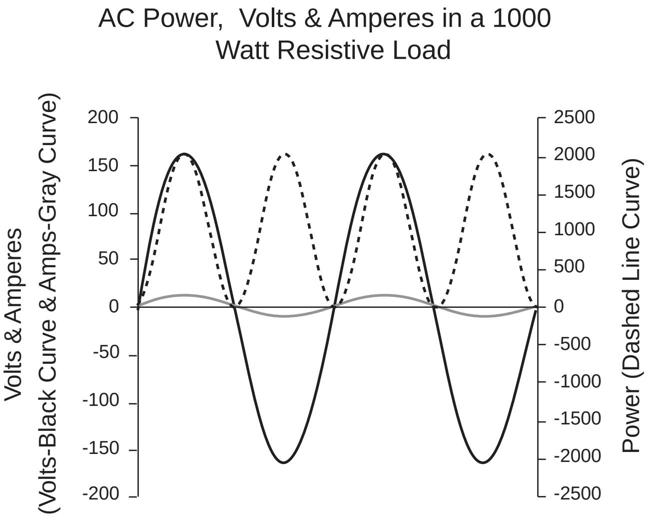


Figure 4

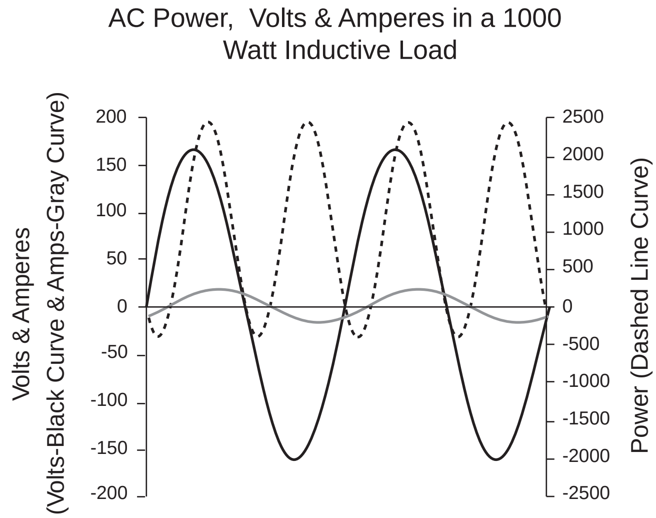


Figure 5

Power in Reactive Circuits
Power is calculated differently in reactive circuits. Instead of just volts times amps, we need to add a factor that compensates for the fact that current is out of phase with voltage. The formula for calculating real power in a reactive circuit is:

$$P=EI \cos \theta$$

where:

P = Power in Watts

E = Voltage in volts

I = Current in amperes

cos θ = cosine of the phase angle in degrees (i.e. the angular difference between the current and voltage waveforms). This angle is negative for inductive loads and positive for capacitive loads.

Power in Inductive Circuits
Figure 5 shows power information for an inductive load. Figure 5 is formatted in the same fashion as Figure 4, but the load, instead of being resistive, is a 1000 watt inductive load with a phase angle of -45° (just like the inductive load shown in Figure 2). Note that none of the three waveforms are in phase with each other. In order to deliver 1000 watts to the inductive load, the current waveform now has peaks of 17 amperes and the power waveform peaks at 2400 watts. Note that portions of the power waveform are now negative. This negative power is power being stored and reflected back at the power source by the load. The portion of the power curve that is below the x-axis of the graph represents the reactance of the load.

Power in Capacitive Circuits
The power situation is much the same for capacitive loads as inductive loads, except that the phase shift is opposite. Figure 6 shows ac power, voltage and current in a 1000 watt capacitive load with a phase angle of 45° (same as shown in Figure 3). Note that once again all the waveforms are not longer in phase with each other. Once again the peak power for the 1000 watt load increases to 2400 watts. Note that just as with the inductive load, portions of the power curve are negative. This negative power is power stored in the load and reflected back at the power source.

In The Real World
What I have shown here is a graphical approach to the use of ac power in reactive loads. In actual use there is no such thing a as a purely inductive or purely capacitive load. All reactive loads have some resistive component. In actual use, there are usually several ac loads being simultaneously powered by the ac source This generates a devious ac parallel circuit of inductive, capacitive and resistive elements.

The difficulty and inefficiency of delivering ac power to reactive loads may be merely technical trivia to those connected to the virtually limitless power of the utility grid. However, the nature of reactive loads greatly effects those using inverters and/or generators. Inverters and generators both make limited amounts of alternating current electricity. Many of the appliances we wish to power from the inverter or the generator are reactive.

So why won't my inverter (or generator) start my well pump?
The inductive load shown in Figures 2 & 5 actually models a 1/2 hp well pump. The graph shown in Figure 5 shows us that the motor in the well pump actually consumes an average power of about 1200 watts (1000 watts of which is actually transferred to the load) and 120 times a second the same motor demands peak power surges of 2400 watts. Consider trying to power

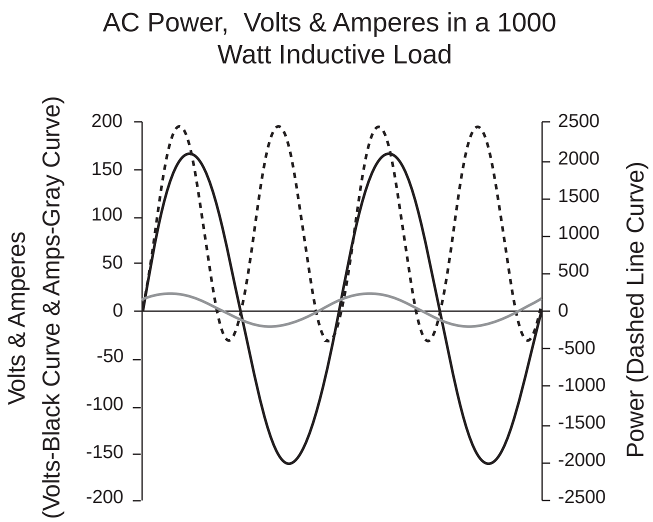


Figure 6

this pump with a 2000 watt generator or a 1500 watt inverter. While the average power consumption of the pump is within the specified limits of the inverter or the generator, the peak power requirements are beyond the capabilities of the inverter or the generator.

What I have shown in Figure 5 represents the steady “up and running” condition for the motor. Before the motor can reach the “up and running” state, it must first be started. When inductive devices like motors are started they have much higher reactance than when they are actually running. Phase angles under starting may be greater than -70°. The starting power requirements of the motor can be 3 to 7 times greater than its running power requirements. This means that it can take over 7000 watts of power to start that 1/2 hp well pump.

If you are planning on powering large reactive loads with finite ac power sources such as inverters or generators, then greatly oversize the power source. With inverters I find that two times oversize is usually enough. With engine/generators oversize the power source to produce three times running power requirements of the large reactive load.

Next time

The next article in this series will provide the mathematical underpinnings of this graphical representation of ac power in reactive loads. It will combine the elements of reactance and resistance into concepts known as impedance and power factor.

Access

Richard Perez, c/o Home Power, PO Box 520, Ashland, OR 97520 • 916-475-3179 • Internet Email: richard.perez@homepower.org


GoPower

Train on My Brain

Michael Hackleman

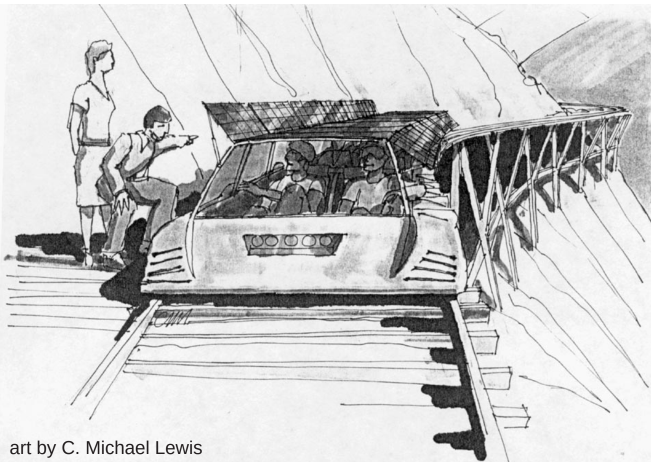
For a long time, I've daydreamed gliding quietly across some high mountain plateau, miles from any road, without pumping any petrochemicals into the air. My airborne version of the machine is an airship that looks like an M&M candy (and that's a whole other story). The landborne version is a rail machine. Part human-pedaled, part solar-charged, part electric-propelled, part gravity-rider.

Arcata Energy Fair and Earthday Event

Rail-related topics got a boost when I attended the Earth Day and Energy Fair in Arcata, CA on April 20th. Kudos to Michael Welch (Redwood Alliance) and volunteers for their part in putting together an informative, fun event. Show goers expecting to hear a keynote speech from Richard Perez got one from me instead. (Richard stayed home to care for Karen who was ill, but is now feeling better.)

At the last moment, I changed my prepared talk to one regarding communities, jobs, skills, tourism, and transportation. I heard myself suggesting that small communities like Arcata and Eureka might want to tackle tough transportation issues from the perspective of "rolling their own." That is, building their own intra-city transportation. The heart of this discussion is auto-free sections of communities.

How do people and goods move in an auto-free section? My vision of this is ultra light rail, or ULR. Imagine rail sections molly-bolted to the pavement of dedicated streets in your town. Lightweight rail machines whisk you about, trolley-like. It's Disneyland's monorail without the amusement park or lofty perch. ULR looks like scaled-up model railroad track, with the track "modules" containing the rail and structural support, signal wires to control traffic lights along the route, and perhaps the power cables (electrifying track



art by C. Michael Lewis

sections only when the vehicles are over them). Where does the hardware come from? Local "talent," in the form of manufacturing facilities, auto-related businesses, and machine shops supply the basic ingredients needed by any community to implement some form of ultra light rail (or ULR).

I concluded my talk by reminding the predominantly Arcata and Eureka crowd of the significance of the Willits-Arcata rail line. This 150-mile stretch of rail has been transferred from Southern Pacific to the North Coast Rail Authority (a public agency) . A similar transfer is underway for the railway extending between Willits and the Golden Gate Bridge District (another 150 miles). These activities are designed to preserve this scenic Northern California corridor for future commuter operation. No segment of this 300-mile long railroad has seen commuter traffic for more than 35 years!

A New Railmachine

Before I left Arcata, I visited with Bart Orlando, builder of the HEC. The HEC is the Human-Energy Converter, a 16-person pedal-power unit that generates electricity for bands (SEER, Oregon Country Fair, etc.). Bart and I have been brainstorming some project guidelines for combining the HEC with the SolTrain. SolTrain, HP readers may recall, is the solar-electrified Speeder that Phil and Richard Jergenson put together and ran on the rails for SEER '92 and '94. I want to move beyond SolTrain, making a sleek, fast, long-range railmachine with BoxBeam. Bart wants to make the next generation of HEC.

Our combined idea is to build a hybrid (human and electric) rail commuter, design it to transport 16-32 people, and run it along the full 150-mile Willits-Arcata corridor. I believe we can get NCRA approval for an inaugural run in the next year. (I salivate at the thought of traveling this route. I've heard stories! The line runs along the Eel River and there's big chunks of it away

from any roads! Juicy.) The timetable is admittedly optimistic, but the right (small) team can do it. Interested? We need talent, materials, workers, and sponsors. Write me for details (enclose an SASE).

In this Issue

Back to NOW. It's an all-electric menu in this issue of Home Power. First, Bruce Johnson, David Goes Electric, walks us through detail on using electric propulsion for agriculture and other useful landscaping applications. Next, in Life with an Electric Car, Shari Prange concludes a 3-part series on building and using an EV. Finally, Tina Sorenson, in Solar Cars for Pleasure and Competition, documents a project originated by John Root. And that's a wrap!

Access

Author: Michael Hackleman, PO Box 327, Willits, CA 95490. email: michael. hackleman@homepower.org

Phil and Richard Jergenson, Suntools, PO Box 1029, Willits, CA 95490. (707) 459-2624.

Above: The author with the electric David Bradley walking tractor.
On the left is a compost shredder converted to 12 V and on the right is a home built 12 V rotary tiller.

David Goes Electric

Bruce Johnson

With solar and wind power working so well for our home, it seemed only natural to put it to use outdoors as well. Here's how I built a small tractor that has become a very valuable tool around the homestead.

The project began with an old David Bradley walking tractor that a friend had given me. It would probably be easy to find a four wheel garden tractor to convert, but I wanted the two wheel design for several reasons. It is more maneuverable and lends itself to the attachment of a sickle-bar mower in front. A four wheel tractor would be heavier and consume more power. I wanted something that would be happy with the 12 Volt power from two golf cart batteries. Also, I enjoy the exercise I get walking. Two more wheels, a seat, and a steering wheel just aren't necessary.

Flea Market Gems

Sears Roebuck & Co. sold the David Bradley walking tractor in the 1940s and 1950s. They were powered by a small gasoline engine and had a whole line of attachments available. They must have sold a lot of

them because they still aren't too hard to find. I see them at our local flea market every spring. There were many other walking tractors built and there also are new ones such as the BCS Mainline. I really like the sturdy construction of the David Bradley and the big 16 inch tires. The extra weight of the batteries is no problem.

The only drawback to the D.B. is that it does not have a differential. Instead, each wheel has a ratchet mechanism in it, allowing the outside wheel to freewheel ahead on a turn. This works fine, except for one thing. If you reverse the motor to back up, the ratchet mechanisms just click away and no power goes to the wheels. I have plans to overcome this, but presently reverse is by the Armstrong method (i.e. you need strong arms to pull it backwards).

Above: David "refueling" at the base of the wind generator tower.

Above: The tractor is parked and its batteries are supplying power for the rotary tiller. In the background is the wind generator, the PV panels, and the water pumping windmill.

Batteries

I began the conversion by mounting the batteries, keeping in mind how the weight would be balanced. One battery is mounted in the front where the gasoline engine originally was. The other battery is mounted in the rear, leaving room in the middle for the motor. Using angle iron with pre-punched holes made fabrication relatively easy. Some old v-belts made good battery hold-down straps.

Electric Drive

The motor I used is a Bosch unit rated 50 Amps and a no-load speed of 2800 rpm. Though the catalog said it was rated for continuous duty, it gets pretty hot when using the tractor in warm weather. I added some cooling fins on the end of the motor where the brush holder is. This motor has plenty of power for the tractor while mowing. For pulling implements with the draw bar, it's a little weak. I've tried it pulling a plow and it will make it with a little help, but a motor with twice the power would be better for pulling implements. I used more angle iron to make the mount for the motor.

The David Bradley originally had a v-belt drive with a disc type clutch, operated by a lever on the handlebar. I used it just as it was for the electric drive. The clutch wouldn't be absolutely necessary, but it's nice to have when starting under load. V-belts are not the best for

Left: The tractor with the sickle bar mower attached at work in the field.

Below: The 32 inch wide Jari sickle bar mower assembly is attached with two u-bolts to the angle iron framework. The drive motor can be seen in the upper right.

efficiency, but they are inexpensive and pulleys of different sizes are easily obtainable. I like to use the "cog" type v-belts that have notches in them to make them more flexible. The fact that v-belts are prone to slipping can even be an advantage. When you run into a submerged concrete block while mowing, it's nice to have the belts slip rather than have something break.

Wiring and Controls

The wiring of the tractor is pretty straightforward. Included is a reversing switch for the motor. As mentioned above, the power isn't transmitted to the wheels while in reverse, but at least you don't have to strain against the whole gear train when pulling the tractor backwards. The switch that controls the motor relay is actuated by the clutch lever. The motor turns on when the clutch lever is released, but before the clutch reaches the point of engaging. When the clutch is disengaged the motor turns off.

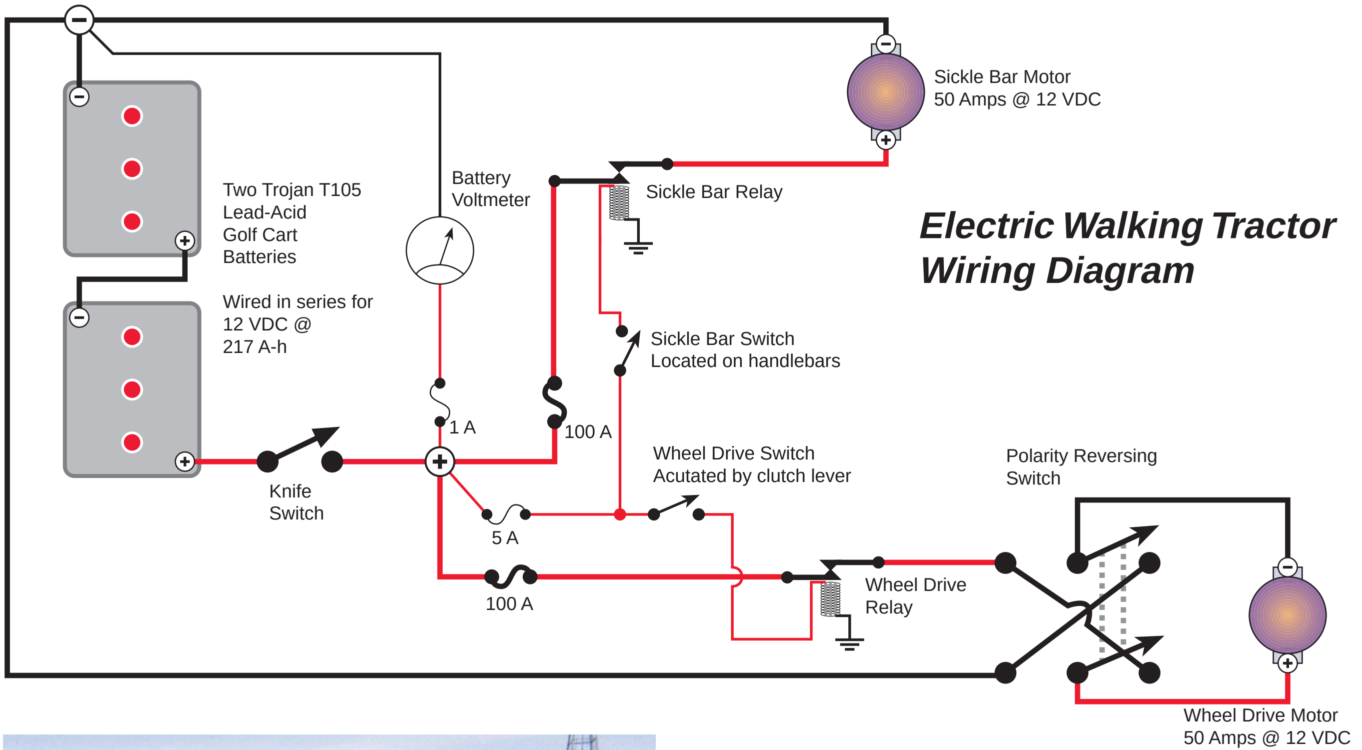
Presently the motor has no speed controller. I used a 1.75 inch pulley on the motor and this gives a ground speed of 1.4 mph which works out fine for mowing. A sliding motor mount and a multi-step pulley would be an easy way to get different speeds. Resistive speed controls are unsatisfactory because they don't provide constant torque and waste power. An EV type MOSFET speed controller would be great, but expensive and not really necessary. I experimented with a controller based on "The Time Machine" (HP #21 page 78). It worked well but was working at the outer edge of it's specifications, so I removed it in favor of reliability. A series-parallel switching scheme for speed control would work too (HP #39 page 53) if you are just using the machine as a tractor. I installed a second motor to run the sickle mower and it requires 12 V full time, so it wouldn't work to be switching the batteries to 6 V for speed control.

Sickle-Bar Mower

With the tractor ready to roll on solar fuel, the next step was to mount a sickle-bar mower. The scissors cutting action of the sickle-bar requires a lot less power than a rotary mower. The David Bradley tractor did have a mower unit that mounted on the front as one of its implements. For electric drive it seemed unnecessarily complex. Also, it attached rigidly to the tractor and I wanted one that would float with the contours of the ground.

I found that the sickle-bar unit from the Jari mower was just what I wanted. I searched for a used or junk one with no luck, so I parted with the cash for a new one. More of the pre-punched angle iron went into fabricating a mount for the mower unit. The drive shaft housing is attached by two u-bolts allowing the unit to swivel so that it can follow the ground. The whole assembly can be removed from the tractor by removing four bolts. The mower motor has the same specs as the drive motor.

It took some experimenting to find the best speed to run the sickle-bar. If it is run too fast there is excess vibration and unnecessary wear. If it is run too slow, mowing will be incomplete. I found that 400 strokes per minute to be good for most conditions at a ground speed of 1.4 mph.



Above: A rear view of the plowing operation.

When mowing, the machine draws 40 to 50 Amps. This is fairly evenly divided between the motor that drives the wheels and the one that drives the sickle-bar. The batteries are rated at 217 Ah. This gives over three hours of mowing time before they need to be recharged. In practice, I usually tire before the batteries do. After a work session, the tractor is plugged into our main 12 V system for the house. We have 12 Amps of PV and a wind generator capable of 40 Amps. We use an Enermaxer for a charge controller. When the tractor is parked in the shed it is connected to a 10 W Chronar panel that keeps the batteries topped up and ready to go.

Other Uses

We use the tractor mainly with the sickle-bar mower, but it has also proven to be a very handy mobile power source for other equipment. It runs a compost shredder converted to 12 V, a 12 V chain saw, or a cement mixer. It also powers a rotary tiller via heavy cables. Add a medium size inverter and it will quietly power a wide variety of tools anywhere you want.

More to Do

Though “David” (as he’s come to be known around our place) has five years of mowing behind him, there are still a number of improvements I would like to make. Some I have already mentioned, like power reverse, a bigger motor, and multi-speed. Another nice touch would be a hood to keep the dust away from the batteries, wiring, and motors. A nice new coat of paint would really make it look first class!

Electric Walking Tractor — Cost of Parts

Quan	Material	Cost
1	Complete 32" sickle bar mower	$400
2	Trojan T-105 golf cart batteries	$100
2	50 Amp, 12 VDC PM motors	$100
	Switches, relays, circuit breakers	$25
	V-belts and pulleys	$15
	Angle iron, nuts & bolts, wire, etc.	$0
	Total	$640

Note: The tractor chassis was free. I've seen them in central Oklahoma for $25–$100, depending on condition and number of implements included.

It's A Great Life!

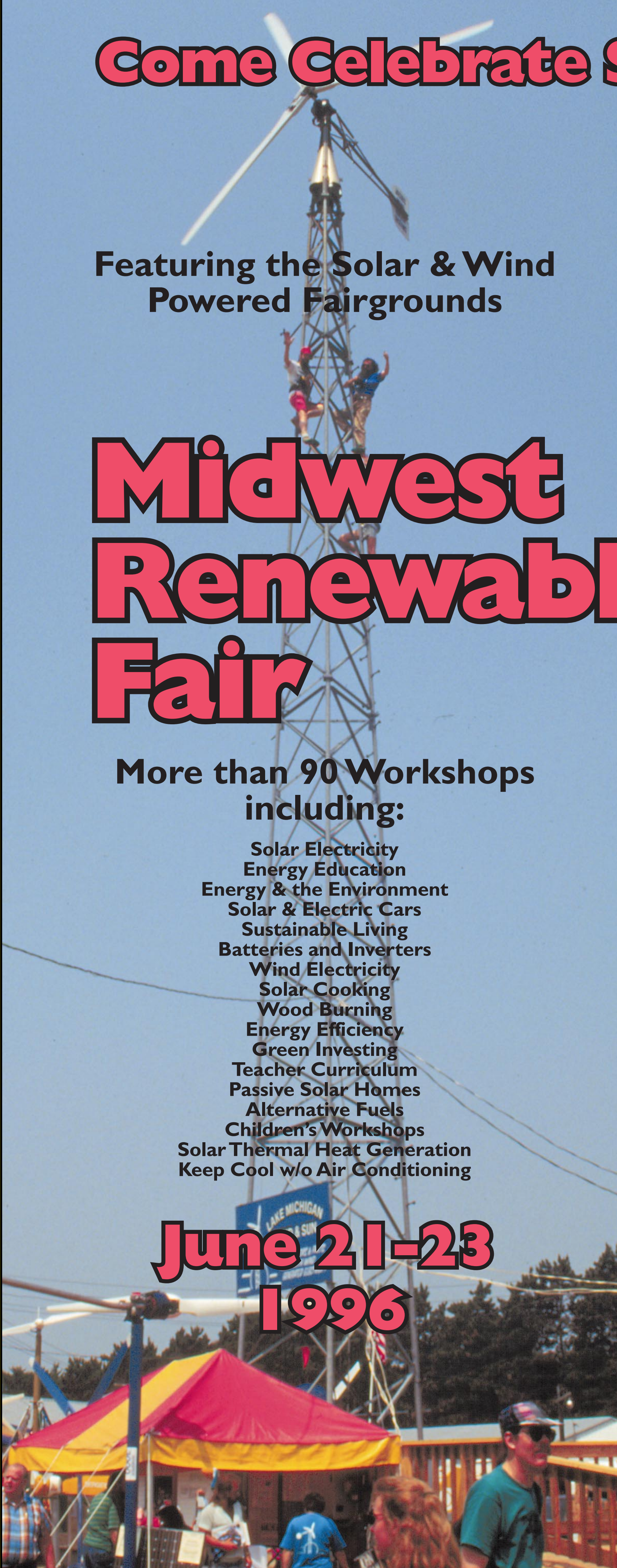
It is a real joy to do homestead tasks with the help of the sun and wind. The first observation from anyone who sees the mower is the how quiet it is. There is only the whirr of the electric motors and the sewing machine-like sound from the sickle-bar. One day we dream of a small electric vehicle for transportation. David has given us the experience and satisfaction to nurture that dream.

Access

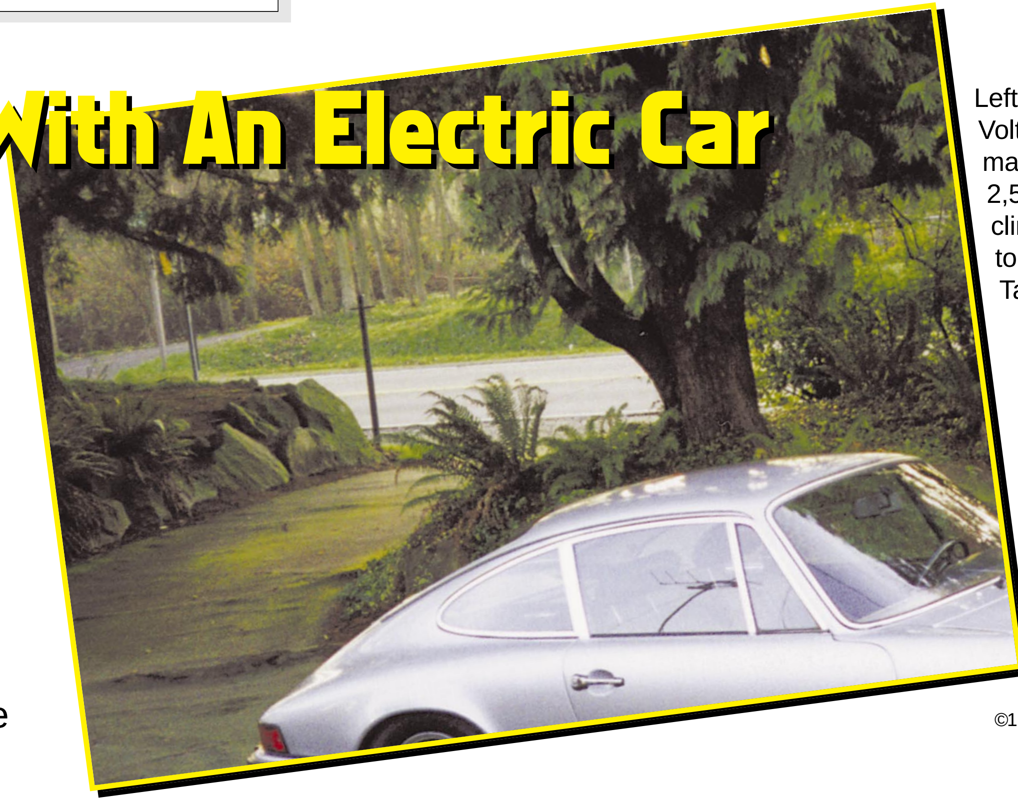
Author: Bruce Johnson, 7605 N. Post Rd., Spencer, OK 73084 • 405-771-3551

Motors, relays switches, and pulleys: Surplus Center, 1015 W. O St., Box 82209, Lincoln, NE 68501-2209 • 800-488-3407

Sickle-bar mower parts: Jari Division of Year-A-Round Cab Corp., Box 2075, Mankato, MN 56001 • 507-625-9381



Life With An Electric Car



Left: The Voltsrabbit makes the 2,500 foot climb to the top of Mt. Tamalpais

Shari Prange

In previous episodes, we have followed Chuck Hursch of Larkspur, California, as he made the decision to own an electric car, and went through the process of accomplishing his goal by converting a VW Rabbit. But the story doesn't end with the celebratory champagne at the car's maiden voyage. Let's follow Chuck a little bit further, while he begins his new life with his Voltsrabbit.

Range

"I had optimistic ideas of an 80-90 mile range, maybe even 120," said Chuck. "The fact of life is more like 50, but I have come to realize that most of my travel is within that range. I can accept that."

Originally, Chuck had wanted to be able to drive to Berkeley and back, since he was thinking of going back to school for a grad degree. However, when he got the car on the road, he was only getting about 30 miles range. He called Mike Brown at Electro Automotive where he had bought the kit, because he was worried that something was wrong.

He soon discovered he was merely experiencing "new conversion syndrome": the batteries and motor weren't broken in yet, the new brakes were still tight, and he was still learning how to drive and charge an electric. With a little road time and experience, the range increased dramatically to a solid 50 miles. Now he feels confident the car could handle the Berkeley commute.

The only time Chuck got marooned was in the first week. He didn't have a charging outlet installed at his apartment yet, so he was charging at a friend's house. He took the car to a shop for an alignment, and the trip proved to be a little beyond the car's range at that time. Now that he can charge at home and the car is well broken in, there are no problems.

Charging

"One of the most important things," said Chuck, "is learning how to charge the car." When he started investigating his low range, he discovered he wasn't getting a full charge on his batteries. His charger had an adjustment for charging voltage, so he cranked it up, and noticed an immediate improvement.

After a few months, the batteries were low on water, so he topped them off. His range dropped for a while, then gradually came up again. As batteries gas and lose water over time, the acid in the remaining electrolyte becomes more concentrated. When Chuck added water, he diluted the acid, and his range dropped off until the batteries had cycled enough times to mix and stabilize again. For consistent performance (and longer battery life) it's better to check batteries and add a little water often, rather than waiting a long time and adding a lot of water at once.

Above: The design of the conversion still leaves a back seat, and plenty of room for cargo.

Performance

"The performance on the highway is what I had hoped for," said Chuck, "except maybe on long grades, but even that isn't a real problem. Climbing a long grade while merging on the freeway is a little slow, but it zips around town just fine. It won't drag race off a stop light, but that's not what I have it for."

Chuck has one short but serious hill at the worst possible place: just before he gets home. The road rises in a 20% grade for 200 feet, and he has to start the climb from a dead stop at the bottom.

At first, the car had problems. It could only make about 13 mph. However, after the car broke in, it came up the hill at 18 mph with no problem. "I've driven 41 miles and come home and still made it up the hill okay," said Chuck.

As a further indication of his faith in the little yellow car, Chuck drove it up to the top of Mt. Tamalpais, a climb of 2,500 feet, to enjoy the view of San Francisco Bay.

Registration & Tax Credits

At least in California, the registration experience varies with the particular Dept. of Motor Vehicles office, the particular DMV employee, how well that employee slept last night, and the phases of the moon, to name just a few factors. You have a better chance of winning the lottery than getting the same answer twice from the DMV.

Chuck was told that the car could not be listed on the title and registration as electric unless it was a commercial vehicle. (This, despite hundreds of private vehicles that ARE registered as electrics.) Since he had no problem getting his state tax credit, and the vehicle was already exempt from biennial smogs by being registered as a diesel, Chuck decided to let sleeping DMVs lie, and leave the registration alone. The car is perfectly legal, the DMV computer just thinks it's a diesel.

Incidentally, the statute under which Chuck got his tax credit expired at the end of 1995. Representative Sam Farr had been instrumental in creating the credit, and it was renewed on a yearly basis. When Farr left the state government for Washington, the tax credit lost its champion, and was not renewed for 1996.

Other tax credits exist in various states, localities, and even in the federal regulations, but these are often poorly funded and written for the purchase of new electric vehicles rather than for conversions.

Insurance

Chuck got liability coverage without a problem, but when he inquired about comprehensive and collision, the response was a little different. "The agents said, sure, they'd write me a policy," said Chuck, "but they seemed to be snickering. I got the feeling if I ever filed I a claim I would have a hard time collecting."

This is ironic, since the insuring company, the American Automobile Association, itself owns electric vehicles in the San Francisco area.

In the end, Chuck decided to self-insure. He feels he

Above: A proud chuck shows off the new baby to his father.

can take the money he would have spent on premiums, put it into an interest-bearing account, and be just as well covered.

Maintenance & Repairs
"I had it into a shop to have the transmission fluid changed and the brakes checked," said Chuck, "and the mechanics looked at the car kind of weird. But there's not much need for service."

After about a year in use, Chuck did have a problem with the controller. While he and Mike Brown were trying to analyze the symptoms, the controller failed completely. Mike shipped Chuck a loaner while the failed unit was in the factory for autopsy.

In the meantime, Chuck mulled it over and decided to exchange his PMC 1221 for the newer 1231 with a higher current limit to give him a greater duty cycle margin for the long and steep grades he drives. With the loaner controller, the down time for the car was minimal while he waited for the replacement.

Outside of that, the biggest problem has been a failed headlight switch that required removing the instrument cluster. While he had it apart anyway, Chuck jumpered a couple of relays to fix a heater fan.

What Do The Neighbors Think?
Chuck lives in an apartment with an open carport beneath the building. Initially, some of the neighbors had concerns about fire hazards or dangers to kids during charging, but Chuck was able to reassure them, and there have been no problems.

The reaction from others has been a little disappointing to Chuck. "People have a different idea than the current reality. They ask how often I charge, and when I tell them, they get turned off. They want to go two weeks. They want 100 miles with room to spare."

Performance is an issue for people who want a "pocket rocket". Chuck said, "They expect some super-sleek 200 mph car. Still, they're impressed when they find out it will do 70 mph. I tell them it's an '80 Voltsrabbit, not a '95 Impact."

Chuck found that people are concerned about convenience first, and benefits to the environment come second. Everyone, however, comments on how quiet it is.

People tend to be more friendly and curious at shows. In the general public, there is some hostility to EVs, which seems to spring from misinformation, and got worse after the infamous Carnegie-Mellon study was released. Chuck had to educate co-workers about common myths, such as the one that EVs simply transfer the pollution to the electric utility.

Happily Ever After
For Chuck, the electric car fits into his life and works. It takes him where he needs to go, and satisfies his desire for freedom from fossil fuels. He may, in the future, upgrade from the basic 96 volt system to as much as 128 volts for a little extra performance and range.

As a final touch, Chuck got vanity plates that read ZEPUREV, which stands for "Zero Emissions Pure Electric Vehicle". A lot of people can't figure it out at first, but it is a conversation opener.

"My boss says it's a weird car," said Chuck, "but that's okay. I got what I wanted. I'm happy."

Access
Author: Shari Prange, ElectroAutomotive, PO Box 1113, Felton, CA 95018 • 408-429-1989

Solar Cars for Pleasure or Competition

Tina M. Sorenson

In the spring of 1995, the University of Dubuque, Iowa, began a model solar car project for students at the elementary level. The project was inspired by the annual Junior Solar Sprint held for sixth, seventh, and eighth grade students. The University felt this project would be great for children because it would expose them to alternative energy which is rapidly increasing in popularity. The child would be able to engage in hands-on activities, thus acquiring a better understanding of mathematics and science. Encouraged to use their own creativity, the students constructed their own solar cars. As John Root's classes progressed, so did the ideas of the students. Furthermore, after learning by trial and error from the two spring classes, our summer classes were a great success.

I was able to assist John Root in many of the classes. I found that the children responded enthusiastically to the project. Many were competitive but were willing to help each other out. When the students had finished their solar cars and were able to test drive them in the sun, they became very excited. In seeing their car run along the track via the use of sunlight, all of the children became very proud of themselves for accomplishing this project.

Beginning Construction—Tools

The primary tools needed are wire cutters, X-ACTO™ knives, electric hand drill, safety glasses, hot glue gun, and other materials chosen for the solar car.

Chassis

The best way to begin is to build the car's chassis, or frame. There are many possible ideas: cardboard tubes, flat boards, shoe boxes, styrofoam, or plastic bottles. One thing to remember when building the chassis is the importance of weight and stiffness. If the car is too heavy, the motor may have a hard time pushing it. Yet, if the car is too light, the wind may push it causing it to either flip over or not run in a straight line. Lighter cars are preferred but stiffness is needed for these cars.

Wheels
Spools, tin cans, foam core, styrofoam, yogurt caps, or anything that resembles a wheel can be used. Again, lighter wheels may run better than heavier ones. Some type of rod will be needed to act as an axle. Tire traction is important. Rubber bands placed around the wheels may aid in traction. A weight may be placed above the back tires to help keep the wheels from slipping. Wheels should be aligned as carefully as possible in order for the car to use less energy and run in a straighter line.

Bearings
Bearings are essential in reducing unnecessary friction caused by the wheels, chassis, and axle. They help the wheels and axle to move freely. We used drinking straws and glue for the bearings, but there are many other ideas including brass tubes or eye bolts. We also used a light lubricant so that the wheel and axle would slide smoothly against each other.

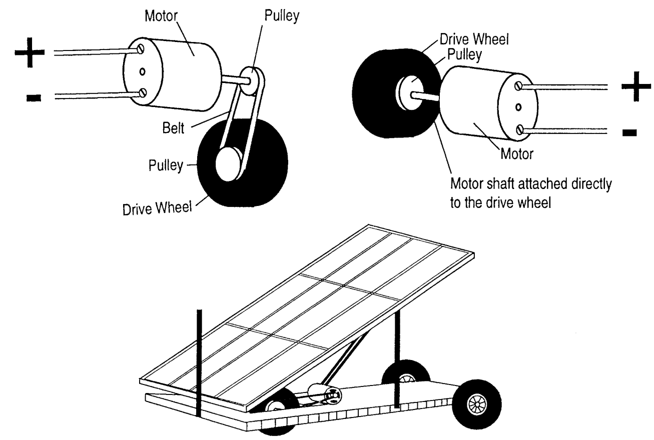
Solar Panel
Last year the solar panel kits were quite inexpensive because the Department of Energy had subsidized them. This year, however, funds are not available and the kits have to be purchased at the full price of $19.99 including shipping. Extra motors are $3.50.

Students were creative with placing the solar panels in various positions. The most popular was a tilted solar panel with reflectors on both sides. The reflectors gave the cars more energy, but the children had a frustrating time making sure they weren't too heavy. The position of the solar panel is very important according to what time of day it is. Many children made their panels changeable through the use of velcro, thus, enabling them to flatten or tilt their solar panels in the direction of the sun's rays.

Transmission
There were a few different ideas the children had for their transmissions. The most popular one was the belt drive, while a few opted for a gear drive.

The type of transmission used directly relates to the speed of the car. The children were able to manipulate the speed of their cars with the gear ratio. There is a back and front sprocket on the transmission, unless using a direct drive. The back sprocket that is attached to the drive wheel can be experimented with in three basic ratios when it is compared to the front sprocket attached to the motor. The back sprocket can be the same size, half the size, or one fourth the size of the front sprocket. Each rotation of the front sprocket will make the drive wheel rotate once if the back sprocket is the same size as the front, but it will rotate two to four times more if the back sprocket is smaller. If the smaller

Solar Drive Transmission Assemblies



SolarMobile

1996 © Graphic F/X by Gregory D. Noble, University of Dubuque

back sprockets are used, the car will essentially move faster, which was the ideal for the children. The faster the cars moved, the happier the children were.

Body
Aerodynamics is the key word for this final step in the construction of the solar cars. The students wanted a shape that would reduce the force of the air. Some materials we used to deflect the air around the car were cardboard, foam core, styrofoam, and plastic bottles.

Junior Solar Sprint
The Junior Solar Sprint usually takes place each year in the spring. The participants are normally seventh and eighth grade students, but some places have sixth grade students. Teachers or anyone else interested can coordinate their own Junior Solar Sprint in local schools. See Access for more info.

Final Thoughts
Helping John Root with this project was a great lesson

Above: At the start, the PVs are uncovered and the race is on!

Above: The kids are enthusiastic about building solar racers!

in life for myself. I not only learned how solar power is converted into electricity and other technical aspects, but I also learned a great deal about children. Children possess a unique and creative quality, and a project like this allows them to explore this creativity. When I was building my car along with them, they were the ones giving me ideas on what to do and how to make my car different. They also wanted to be challenged—to be the best one in the class. After the cars were finished and we raced them for the first time, the children became very proud of their work. Some, however, were a little embarrassed because their cars may not have been as good as others. But when they saw the faster cars racing against each other they were the first ones to put aside their hurt egos and cheer.

I also realized how important hands-on projects are for children. After John explained to them how solar power works and what the procedure would be, the children were anxious to dive into the work. They were ready to accomplish a goal, and they were ready to do it together as a team. Many made mistakes, but correcting those mistakes was a great experience for them. No one failed with their projects. They all succeeded in getting their cars to play out in the sunlight and many expressed the desire to reassemble their cars to make them even better after the class was completed. Thus was displayed the great success such projects can have on children yearning to release their creativity.

Access

Author Tina M. Sorenson, University of Dubuque, CPO 689, Dubuque, IA 52001 • Email: tsorenso@univ.dbq.edu

Junior Solar Sprint info or to inquire about the solar cells, Gloria Kratz, NREL, 1617 Cole Blvd., Golden, CO 80401 • 1-800-NEW-ENGY

Net Metering Update

Don Loweburg

On April 10, 1996 the California Public Utilities Commission (CPUC) adopted a revised Southern California Edison rate case decision eliminating all standby charges for net metering customers. This is good news and is the result of work by the California PV Collaborative. The Collaborative is distributing a sample tariff and connection agreement to all California utilities. If any Home Power readers would like one, you may contact me. Two major Northern California utilities, PG&E and SMUD, still don't have an acceptable net metering policy.

Rate Based Incentives

Tom Jensen of Strategies Unlimited and Michael Welch did an extensive *Home Power* article on this subject a few months ago. They described how through local initiative, funding can be developed and made available to stimulate PV system purchases. Power produced with PV is purchased at premium rates using the fund. Under this program only performance is rewarded. No public funding is used to purchase hardware. Equipment and services purchased are made on the competitive market, thus stimulating and growing the local PV economy.

On April 26 at the California PV Collaborative meeting in Sacramento, Tom Jensen provided follow up information on how these programs are growing and flourishing in Europe. In the Swiss town of Burgdorf, where the first program began in 1991, there are now over 186 KW of installed PV. This is especially remarkable since the town has a population of only 15,000. In Germany equally impressive programs are taking off. Programs exist in many cities including Munich and Hamburg. The German programs started in 1995 with 100 KW of PV. The 1996 level of deployed PV is expected to exceed 1.5 MW, a ten fold increase in one year.

California may be the site of the first Rate Based Incentive (RBI) program in the United States. The city of Davis is exploring such a program. Hopefully we will have more information on this project in the coming months. Readers in other communities wishing more information and contacts for RBI feel free to contact IPP.

More California PV Collaborative News

The California PV Collaborative met on April 26, 1996 with reports and information on a number of on-going projects designed to accelerate the commercialization of PV.

Financing and Marketing

Joel Davidson of Solec reported on the marketing committee. Information on net metering will be sent to California utilities and their customers. Also discussed was setting up an information clearing house on successful PV projects and encouraging installers and others to use press releases to inform the general public about these projects. Joel also announced that Sumitomo, Solec's parent company, will be providing financing for qualifying PV projects. Vince Schwent of the California Energy Commission informed the group that REDI (Renewable Energy Development Institute) has begun a project to form a financing database of renewable energy projects. Keith Rutledge of the Bank of Willits, California will be in charge.

Southern California Edison's on-grid PV approved March, 1996

The CPUC, after many months of delay, approved Edison's on grid PV advice filing. Because SCE did not ask for ownership of customer sited systems, IPP did not oppose this program. Edison's program will be very much like the off grid program approved two years ago. In both programs Edison will provide a financing-lease mechanism by which the customer can own the system. There are two ways an Edison customer can use the program. If a customer requests, Edison will design the system and put the job out for bid with the successful contracting company selling, installing and servicing the

system. The second option allows the customer to preselect a PV provider and then go to Edison for financing. The financing charge per month in both cases is determined by the system cost multiplied times .016. For more information and a list of IPP contractors drop me a line. In both cases, the customer must be in Edison's service territory. Doug Whyte of SCE stated that the on-grid program is slated for a June 1, 1996 roll out.

PVUSA Under New Management

PVUSA is an extensive deployment of utility scale PV projects. Until last year the project was operated by Pacific Gas and Electric (PG&E). The project has served as a valuable test bed for PV modules of different technologies and manufacturers and system related equipment such as inverters and connectors. In the next few months the CEC will take over the management of the project while Sacramento Municipal Utility District (SMUD) will do plant operations. Nancy Jenkins, CEC manager of the project, solicited suggestions from the collaborative in shaping the future of PVUSA. Two suggestions were made. Joel Davidson of Solec requested that PVUSA continue to accept demonstration installations. He stated that the site serves as a showcase for PV technology and therefore should allow new projects. The second suggestion from IPP was that the site be used to train PV interns, possibly university students but not limited to them.

Renewables Portfolio (Restructuring)

As stated in the last issue, the CPUC has stated the desirability of protecting renewables in a restructured competitive energy market. Several months of meetings are scheduled in order to develop a plan for the commission's consideration. One possible plan was presented to the Collaborative by Vince Schwent of the CEC. His plan would divide renewable energy into bands. These bands would represent both specific technologies and also correlate to technology cost. For instance wind is almost competitive with other generation, therefore wind has a big band but small price subsidy (in the form of a saleable Renewable Energy Credit, REC). The smallest band would represent the least deployed (or developed) technology, PV. The market share is small but the subsidy per kwh is greatest In general, IPP doesn't have a problem with this plan but the issue of PV system ownership is not addressed. We would have problems with any plan that allowed utility ownership of customer sited systems. Theoretically under restructuring and retail electric power competition, the utilities are getting out of the generation business and this should not be an issue. . Another detail that is not spelled out is how utility connected net metering customers are treated. An incentive program that rewards investors for developing PV generation capacity should also reward endusers (home owners) for doing so.

What's Happening in Idaho

I got this information from an IPP member just as we are going to press. I was told that Idaho power is attempting to rescind an existent net metering policy. This is really going backwards. The Idaho public needs to get on this. I also found in documents on file with the Idaho Public Utilities Commission that Idaho Power has passed on to the ratepayers over $660,000 in costs related to their pilot offgrid program. To quote Idaho Public Utility Commission order No. 25880 "We find the ten-year amortization period is appropriate in this case, as it is consistent with the previous Order of the Commission. This adjustment for accumulated photovoltaic expense increases rate base and reduces expenses by $66, 222 (this is per year, so the total being rate based is $662,000 and change)." This is exactly the opposite of the situation in California. Here the CPUC specifically prohibits the passing of offgrid costs onto the ratepayers due to anti competitive concerns. The ratepayers in Idaho are subsidizing the utility while it competes with private businesses.

Access

Author: Don Loweburg, IPP, PO Box 231 North Fork, CA 93643 • 209 877 7080 • Internet Email i2p@aol.com

To join IPP or send tax-deductible donations: IPP, PO Box 231,North Fork, CA 93643 • E-mail: i2p@aol.com • 209-841-7001 or 916-475-3402

Doing It With Disconnects

John Wiles

Many PV systems have been installed without disconnects of any kind. With bolted and soldered connections, one wonders how the components of the system are safely serviced and how the system is turned off in an emergency. This Code Corner will discuss how to implement the requirements of the National Electrical Code (NEC) that relate to disconnects.

Definitions

A disconnect is any device that allows an electrical circuit to be interrupted or disconnected. Two wires that are bolted together with a split-bolt connector or that are spliced through a power block have a disconnect. This form of disconnect is not very accessible and it is extremely difficult to open the circuit quickly—even if the proper tool is available.

Switches and circuit breakers can be used as disconnects when properly rated for the current and voltage that they must carry. In the case of circuit breakers, they act not only as the disconnect device, but also serve as the overcurrent device discussed in Code Corner in *Home Power Magazine* #52.

NEC Requirements

The National Electrical Code requires that disconnects be installed in several locations in a PV system. The more complex the PV system, the more disconnects that are required.

In a simple, direct-connected (PV to load) system like a water pumper with no batteries or other source of power, only a single disconnect is required. In a complex hybrid PV systems with generators, batteries, PV, and possibly wind and hydro inputs, the number of disconnects mounts rapidly.

At each location where a disconnect is required, it must disconnect all ungrounded conductors of the circuit. In a 12-volt, ungrounded system, a disconnect must be placed in both conductors; this will require a two-pole disconnect. In grounded PV systems where one of the current-carrying conductors (normally the negative) is grounded, only one-pole disconnects are required. Disconnects (other than bolted terminal blocks) are usually not installed in grounded conductors—particularly in PV systems where there is more than one source of power. Significant reductions in cost can be achieved by grounding even 12-volt systems since the ground rod is required in all systems for the equipment grounds—the subject of a subsequent Code Corner.

The NEC requires that all sources of power have disconnects from the conductors in a building or to the load circuits. This will require at least one disconnect on the PV system, one on the batteries, and one on any other source of power such as an engine-driven generator, hydro generator, or wind turbine.

All pieces of equipment in a PV system such as inverters, charge controllers, and other devices likely to need service are required to have disconnects so that all power can be removed from these devices before they are serviced. The disconnects mentioned in the previous paragraph may also serve as the equipment disconnects if they can remove all power from the equipment.

Installation

Disconnects must be installed so that the handles, in the highest position, are no more than six and one half feet above the floor. Disconnects can not have exposed terminals or other parts and should be mounted securely to the wall or panel.

Any electrical panel, including those containing disconnects, must have a clear working space from the floor up to the panel or disconnect with nothing protruding into that space. Mounting a disconnect that has an eight-inch deep enclosure is not allowed over a battery bank or inverter that is significantly deeper (10-12 inches or more) and that protrudes into the clear space below the disconnect.

Grouping

The main power source disconnects must be grouped together, and no more than six motions of the hand should be required to disconnect all sources of power. That means one disconnect for the PV, one for the battery, one for the generator, and three left over for the utility, the hydro system, and the wind turbine.

Some electrical inspectors require additional disconnects near the source of power (somewhat similar to the roof-mounted air conditioner disconnect). These inspectors may require an additional disconnect for the PV array at the base of the mounting pole in the back yard. A disconnect at the generator (hopefully outside) is also usually required. These disconnects will

be in addition to the grouped disconnects on the same circuit inside the building near the power center.

Battery disconnects should be located as close to the batteries as possible without being in the battery room or enclosure. Arcs and sparks from disconnects are not compatible (i.e. explosive) with hydrogen gas.

Although not an NEC requirement, yet, the location of the main disconnects should be clearly marked at a prominent location on the outside of the building. This is necessary so that firemen can turn off the power to the structure in the event of fire.

DC Ratings

In all cases (switches or circuit breakers), all disconnect devices used in PV systems on direct-current circuits should be listed by a recognized testing agency (UL or ETL) to the appropriate UL Standard and rated for operation on direct-current (DC) circuits at the appropriate voltage and current. Many switches and circuit breakers are not suitable for DC.

Most DC-rated devices have the ratings printed directly on the body of the circuit breaker or on the switch housing. If there is any question, the manufacturer can provide the DC ratings as established by the UL listing, if there has been a DC rating established at all.

For example, the common Square D Residential QO Series of circuit breakers has a voltage rating of 48 volts DC. Since these are low in cost and readily available, they are frequently selected as disconnects for PV array combiner circuits and DC load centers. They are perfectly satisfactory for this use when they are connected to the battery through a current-limiting fuse. While the fuse and its required disconnect switch are somewhat expensive, they do allow the use of the inexpensive Square D circuit breakers as disconnects elsewhere in 12-volt systems.

Current Ratings

The disconnect device, when used as a disconnect only and not as combined disconnect/overcurrent device, in PV array circuits should have a current rating equal to or greater than the ampacity of the cable, and that rating should be at least 156% of the rated short-circuit current from the module or array. This rating will comply with the requirements established by UL and the NEC. A circuit breaker, when used as a combined disconnect/overcurrent device, should be rated as described in Code Corner in *Home Power* #52.

Disconnect devices on other dc-load circuits should be rated at 125% of the continuous steady-state currents and, as before, be rated equal to or greater than the conductor ampacity.

Voltage Ratings

Disconnect devices used to switch PV module and array circuits should have a voltage rating of at least 125% of the PV array open-circuit voltage. The common Square D QO circuit breaker with a 48-volt rating can be used in 12-volt systems that have a 22-volt open-circuit voltage (125% of 22 is 27.5 volts), but not on 24-volt PV systems that have an open-circuit voltage of 44 volts (125% of 44 is 55 volts). Circuit breakers such as those made by Heinemann, Phillips (Airpax), and others have either a 65-volt or 125-volt DC rating depending on the particular unit and the interrupt rating.

Disconnects on DC battery circuits should have a voltage rating equal to the highest equalization voltage of the battery.

Disconnects on ac circuits should be rated for the nominal ac voltage.

Summary—Do it with disconnects

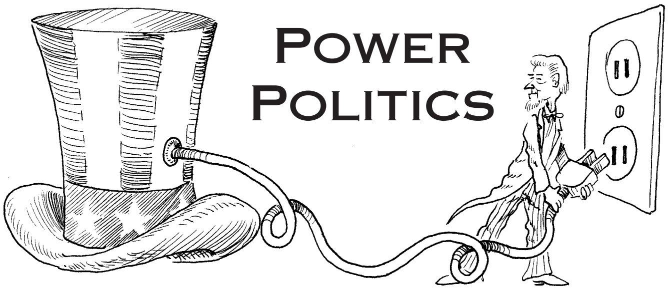
Install the appropriate disconnect devices where required by the NEC. They should be listed to UL Standards and have the appropriate DC voltage and current ratings. A safe and sane system is achievable that will meet the code and won't require an engineer to operate.

Access

Author: John C. Wiles • Southwest Technology Development Institute • New Mexico State University • Box 30,001/ Department 3 SOLAR • Las Cruces, NM 88003 • Phone 505-646-6105 • FAX 505-646-3841

An NEC Article 690 Task Group, chartered by NFPA, is working on the 1999 NEC with a Technical Review Committee from the Solar Energy Industries Association (SEIA). Those wishing to actively participate should contact Ward Bower at Sandia National Laboratories • 505-844-5206

National Electrical Code (and NEC) are registered trademarks of The National Fire Protection Association (NFPA). The 1996 NEC and the NEC Handbook are available from NFPA • 1 Batterymarch Park • Quincy, MA 02269-9101 • 800 344-3555 • 617-770-3000



RE=Life

Michael Welch

As I write this, it is the tenth anniversary of the worst industrial accident and environmental disaster in history. As you read this, you will probably realize that the anniversary passed without you even noticing it. On April 26, 1986, there was an explosion and fire at the Chernobyl nuclear power plant in the Ukraine.

The Chernobyl disaster has significant meaning for me, and is one of the big reasons why I am still an energy activist, as I have been since I first heard about a major accident at the Three Mile Island nuclear power plant in 1979. Both those accidents verified faulty reactor design, faulty construction, incompetent management, human error, and well planned and orchestrated cover-ups of problems and accidents.

30 Dead or 130 Thousand?

In October I was watching a major network news anchor touch on the Chernobyl accident. I was appalled when he stated that 30 people died. The Ukrainian Ministry of Public Health estimates that 125,000 died in their region. Reports are that another 8,000 died in Russia.

Hundreds of thousands of people were permanently evacuated from their homes and farms, while millions still live on and eat from their contaminated lands. The size of the contaminated area of Ukraine and Belarus is about 61,780 square miles. This region was once a major agricultural area for the onetime super-power, the USSR. In fact, the Chernobyl accident may have been the last straw that ended Glasnost and caused the break-up of the USSR. Not only were the people fed up with the lies and cover-ups from Moscow, but politicians did not want to take on the extensive financial burden of the needed clean-up.

Another Chernobyl Disaster?

Soon after the explosion and evacuation, an “airtight” sarcophagus of concrete was hastily constructed around the plant. Now it is revealed that this containment has failed. According to scientists at the site, rain and air can freely pass through 11,000 square feet of holes in the structure that was intended to contain the 180 tons of burned nuclear fuel remaining. Scientists are puzzling over how to prevent or contain the eventual collapse of this colossal concrete tomb. Once the crumbling concrete pillars fail, another catastrophic airborne release of highly radioactive particulate may occur.

Accident without End

Many people, mostly fire fighters and cleanup crews died immediately after the accident, but the real toll is now becoming clear. Much of the radiation released by Chernobyl is still in the area, soaked up in the ground and brought back to the surface by plants and livestock. Wind and water continue to spread the radioactive contamination. Ground water flowing under the damaged reactor is spreading an underground radioactive plume into the Pripyat and Dnieper Rivers, threatening the city of Kiev’s water supply.

Birth rates have fallen drastically. Thyroid cancer rates are spiralling upward in affected areas. Children and the unborn are specially susceptible to radiation’s effects. Birth defects are commonplace, and radiation readily attacks immune systems, making people more vulnerable to other diseases. Cancers will be rearing their ugly heads, as their more lengthy incubation periods come closer and closer.

Disaster Relief

Unfortunately for the Ukrainians, there is virtually no international relief available to them. And since their country is so poor, especially since the accident, there is not much their own citizens can do to help.

Had this been an earthquake or an oil spill, you can bet that corporate and international politics would be put aside to get them help. But, there are two strikes against outside help. First, the effects of this disaster are so huge and so far-reaching, that the magnitude of help needed is overwhelming, even for the richest of countries like the U.S. Second is the power and politics of the international nuclear power corporations. The nuclear industry has, as you might expect, ignored the plight of the Ukrainians. They would prefer that the whole thing slip from the public’s mind, as it largely has. This way they can continue on with their programs to sell nuclear power plants to third world countries and continue putting smiley faces on their resurgence plans here in the U.S.

Folks Want to Help

There are organizations that are trying to help the Ukrainians. The Redwood Alliance, Nuclear Information

and Resource Service, Children of Chornobyl Foundation and other concerned non-profits are operating a campaign to get much needed items to the Ukraine. This campaign was intended to go through the anniversary month of April, but they will be sending relief items on an ongoing basis.

Please open up your hearts and wallets to these people. They are in desperate need of medicines to help ward off the illnesses that their crippled immune systems can't fight off. Cash is very much needed to ship the relief supplies and to purchase additional relief supplies at cost. Mark your checks for the Chernobyl Fund and send them either to Redwood Alliance or NIRS (see Access).

No More Chernobyls

Disaster relief is not the only aim of this project. We want to make sure it won't happen again elsewhere. In spite of all the assurances we are given by the good old boys in control of the nuke industry, this could happen again, even in the U.S. where regulations are far more stringent than other countries with nuke plants.

Some have argued that the Chernobyl reactor design is inferior to those built in the United States and, therefore, such a disaster could not happen here. But the truth is that the containment system used in the Chernobyl reactor was modeled after that of the General Electric Mark I reactor. There are 24 U.S. nuclear plants with that design. Soon after the Chernobyl disaster, a U.S. Nuclear Regulatory Commission official estimated that those U.S. reactors have a 90% chance of failure during a severe accident.

A Mobile Chernobyl?

The potential movement of radioactive waste through the U.S. is a disaster waiting to happen. Beginning in the late 1950's, each nuclear plant has been stockpiling radioactive waste, waiting for a solution to its disposal. Now the utilities are pressing Congress very hard to denote an "interim storage facility."

In other words, they want to get rid of the responsibility for creating the waste, leaving taxpayers with the "ownership" of that waste. One problem is that the deadly waste will have to be shipped through 43 states to get to the proposed facility in Nevada. Each cask of high level waste would carry the long-lived radiological equivalent of about 200 Hiroshima-sized nuclear bombs, yet would need to travel through many of our largest cities, including New York, Chicago, Washington, Philadelphia, and Los Angeles. Can you imagine your community's emergency personnel being able to handle such a catastrophe if one of these casks derailed in your neighborhood?

Fortunately, there is a better way. Leave the deadly waste where it is—where it was generated by nuclear utilities—until our nation has completely and adequately re-evaluated our radioactive waste policies.

Unfortunately, Congress has a different idea. Many members of Congress are supporting the idea of forcing an interim storage site upon the state of Nevada, which would mandate large scale radioactive waste transportation across our country as early as 1998.

OK, Call the Politicians

There are bills in both houses, HR 1020 and S 1271, which would mandate the movement this deadly radioactive waste. Call and write your Congressmembers and Senators right away asking them to vote against these bills. President Clinton also needs your calls and letters demanding for a veto in case the bills pass through Congress. The phone numbers and addresses are in Access.

Access

Author: Michael Welch, c/o Redwood Alliance, PO Box 293, Arcata, CA 95518. 707-822-7884 voice, 707-822-8640 computer BBS, Internet: michael.welch@homepower.org, http://www.igc.apc.org/redwood/

Nuclear Information and Resource Service, 1424 16th St. NW #404, Washington, DC 20036, 202-328-0002, Internet: nirsnet@igc.apc.org, http://www.essential.org/nirsnet/

Children of Chornobyl Foundation, 272 Old Short Hills Rd., Short Hills, NJ 07078, 201-376-5140 (The Chornobyl spelling is different because they use an translation closer to the Ukrainian spelling.)

U.S. House of Representatives, 202-224-3121 (ask for your representative) • [Your representative's name] US House, Washington DC 20515.

U.S Senate, 202-224-3121 (ask for your senator) • [Your Senator's name] US Senate, Washington, DC 20500.

Kathleen Jarschke-Schultze

Never having owned or even lived with a dishwasher before there were a few things to learn about the day to day usage. I have to admit I am having a wonderful time with the Asko. It is as fun as I thought it would be.

Do I Need a Dishwasher?
When I was about nine years old I began washing my family's dishes. I shared this task with my older sister Mary, who had been doing the chore by herself for several years. We traded, one week her and one week me. With a family of six, soon to be seven, I had plenty of time to ponder life's questions there at the sink. I told myself I would have an automatic dishwasher when I grew up.

As an adult I was never in one place long enough to get a dishwasher. I never lived in a house new enough to have one built in. Now that Bob-O and I have settled down I knew it was really time to go for it. Bob-O saw no real need for such an extravagance. I was doing a fine job he said. As my work for *Home Power* took up more of my time I delegated the chore to include our family. First my turn, then Bob-O's, then Allen's. Soon a dishwasher was not an extravagance but a time-saving tool to be used and appreciated. Imagine that!

Asko Model 1355
The Normal cycle of any model Asko uses only 4.6 gallons of water. The Pots and Pans cycle uses 5.8 gallons. The Light cycle uses 3.7 gallons. We found the water consumption was so low that our Myson on-demand water heater was not heating the water enough. The Myson has to have 3/4 gallon per minute flow to fully turn on. The Asko uses so little water there is not time for the water to get hot. We have been using the Temp Boost option. When on, the heating element heats the water to 140° F no matter what the temperature was to start with. When we do not use the Temp Boost there is soap residue left in the dispenser. This indicates the water isn't quite hot enough. When all our hot water comes from our Thermomax collector during the summer and fall months, this won't be a problem. For anyone using a tank-type water heater this shouldn't be a problem either.

Controls
The 1355 is the only model with manual controls. All other models have electronic controls, which are probably phantom loads.

The control panel is very basic. There are two buttons. One is for the Temp Boost, on or off. The other button is for heated fan dry, on or off. When the unit gets to the dry cycle we just open the door and pull out the racks to let the dishes air dry. Unfortunately there is no handy indicator on the control panel to let us know when the dishwasher enters the dry cycle.

I have a magnetic kitchen timer that sticks to the front of the Asko. On cycle # 3 with the Temp Boost on, the one we have used exclusively, it takes 1 hour and 23 minutes to get to the dry cycle. So when the alarm goes off we open the door and pull the racks forward. All the dishes are steamy hot and dry quickly. This is also a good time to tip the glasses and bowls that have dips in their bottoms and pour off any excess water.

There is one knob to turn to start the washer. There are six numbers indicating which cycle is available. You turn the knob so that the cycle number you want is at the top. When we open the door to air dry the dishes we have to be sure to turn the knob to off. The cycle would just pick up where it left off if we didn't.

Cycles
There are six cycles to choose from. #1, Rinse and Hold. #2, Pots and Pans. #3, Normal Wash. #4, Light Wash. #5, Rinse. #6, Plate Heating. We don't use Rinse and Hold. We rinse by hand right away. We don't use the Light Wash because every load is a full load of an assortment of dishes, silverware, bowls, pots and pans.

After using the Asko for two months we average one load of dishes every three days. This works fine because when the dishwasher is full we are out of clean dishes. My friends say the Rinse cycle is really a time and hassle saver during the canning season. I will be able to rinse and heat canning jars for filling. For me the plate heating cycle is ludicrous.

Performance
We made a spreadsheet, naturally, and taped it to the cupboard above the Asko. All tests were done on cycle #3 and testing lasted from 9 March 1996 to 30 April 1996. During this period we ran 18 cycles of the dishwasher and used the Temp Boost on 72% of those cycles. I rate the Asko at a solid 10 on a one to ten scale. Average energy consumption was 346.5 Watt-hours per load with Temp Boost off. Energy consumption with Temp Boost on was 1290 Watt-hours per load. Incoming water temperature to the Asko was between 60 and 140°F.

Dishwasher Dharma
I am learning dishwasher technique. Don't wash knives with wooden handles or steel blades. The wood dries out and the blades have rust spots. You need to rinse all the dishes first. This means a quick rinse as soon as you are through soiling it.

We are in a training mode now. Use, rinse, and load. I got a flat magnet, covered it with white paper on both sides. One side says 'DIRTY' and the other side says 'CLEAN'. As soon as I set the timer and start the load I turn it to 'clean'. After I unload the washer the magnet is turned to 'dirty'.

Spatulas that have been used to fry eggs, potatoes, or similar foods must have all the gunk off them first. I usually wash them by hand with the wooden spoons and wood handled knives. There is a basket in the filter on the floor of the unit and it is easily emptied. I washed my wok and it got stripped down to bare metal. I had to re-season it.

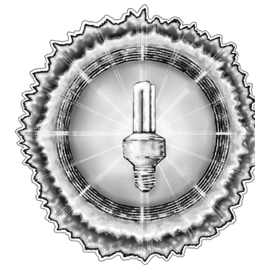
Cost
The Asko 1355, the least expensive model of Asko dishwashers offered, was $810. This is a bit more expensive than the top American brand.

Warranty
The Asko 1355 has several warranties. All of these warranties run from the date of purchase. There is a one year full warranty that covers defects in materials or workmanship. Asko will pay for any necessary replacement parts and/or repair labor. Service must be provided by an authorized Asko service outlet. There is a five year warranty, full for the first year (labor costs and replacement parts) and limited for years two through five (replacement parts only), that covers any defective solid state controls, timers, motors, pumps, or dishwasher racks. There is a twenty-five year warranty, full for the first year (labor costs and replacement parts) and limited for years two through twenty-five (replacement parts only), that covers the stainless steel tank and stainless steel inner door panel if they fail to hold water due to a manufacturing defect, such as cracking or rusting.

Access
Kathleen Jarschke-Schultze is stopping and smelling the roses at her home in northern-most California, c/o *Home Power Magazine*, PO Box 520, Ashland, OR 97520 • 916•475-0830 • Internet Email: kathleen.jarschke-schultze@homepower.org
or: kjs@snowcrest.net

Asko Inc. POB 851805, Richardson, TX 75085-1805

Home Power's Business



"The man who on his trade relies
Must either bust or advertise."
Sir Thomas Lipton — 1870

Display Advertising

Advertising Rates per Consecutive Insertion

	Single Insertion	*Three Insertions*	*Six Insertions*	*Ad Area sq. in.*
Full Page	$1,200	$1,080	$1,020	64.13
Half Page	$672	$605	$571	32.06
Third Page	$480	$432	$408	21.38
Quarter Page	$377	$339	$320	16.03
Sixth Page	$267	$240	$227	10.69
Eighth Page	$214	$193	$182	8.02
Twelfth Page	$150	$135	$128	5.34

Four process color (CMYK) in any sized advertisement for a flat rate $185 per insertion. For inserts, and current subscriber/circulation demographics, please call us.

Home Power is published bi-monthly. Ad deadline for the Aug / Sep 1996 issue (*HP* #54) is 25 June 1996. Call or FAX 916-475-3179 for further details.

International *Home Power* Subscriptions

Due to the high cost of international mailing, we charge more for *Home Power* international subscriptions.

1 YEAR — 6 ISSUE INTERNATIONAL RATES:

All payments in U.S. currency ONLY!

Canada:	Air — $36	Surface — $30
Mexico:	Air — $38	Surface — $30
Western Hemisphere:	Air — $40	Surface — $30
Europe:	Air — $53	Surface — $30
Asia and Africa:	Air — $64	Surface — $30
Pacific Rim:	Air — $64	Surface — $30

Surface shipment may take up to three months to get to you. All international issues shipped in mailing envelopes. International subs are best paid for by either VISA, MasterCard, or funds from a U.S. bank.

International orders call: 916-475-0830
or FAX 916-475-0941

MicroAds

MicroAd rates are 10¢ per character. Characters are letters, numbers, spaces, and punctuation marks. $15 minimum per MicroAd insertion. Send check with your ad. We do not bill MicroAds.

Home Power Magazine for Resale

Quantities of *Home Power Magazine* are available for resale by distributors, newsstands, bookstores, energy businesses, and others. Please call or write for rates and shipment specifics.

Back Issues of *Home Power Magazine*

Back issues through #20 are $3.25 each ($4.25 each outside USA) while they last. Sorry no more issues #1–#10, #12, #14, #15, or #36. Back issues of #21 through #45 are $4.75 each ($6 each outside USA). Back issues #46 to the present issue are $5.75 each ($7.25 outside USA). All back issues are shipped First Class mail in an envelope or box. See this issue's ad index for current *Home Power* back issue specials. The text and line art from back issues #1–#37 on CD ROM (IBM & Mac) at $29 each.

First Class *Home Power* Subscription

Home Power Magazine (6 issues) via First Class U.S. Domestic Mail for $36. Many of you have asked for faster delivery of your issues. So here it is: First Class *Home Power*. All First Class issues shipped in an envelope. We start your subscription immediately with the current issue.

Second Class *Home Power* Subscription

Home Power (6 issues) via Second Class U.S. Domestic Mail for $22.50. Second Class is forwardable for one issue (2 months), so let us know immediately if you move! We start your sub with the next scheduled issue, so please allow ten weeks for your first copy to arrive.

ACCESS ➠ *Home Power*, PO Box 520, Ashland, OR 97520 USA

800-707-6585 or 916–475–0830 Subscriptions and Back Issues

916–475–3179 Advertising and Editorial

Join us and get your hands-on

Learn the practical use of solar, wind & water power.

Hands-on Workshops in CARBONDALE, COLORADO

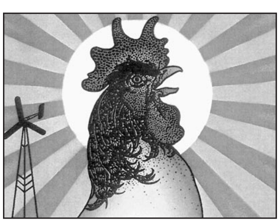
• PV Design & Installation	May 28 – June 7
• Advanced Photovoltaics	June 10 – 21
• Solar Cooking	July 1 – 3
• Micro-Hydro Power	July 8 – 19
• Wind Power	July 22 – August 2
• PV Design & Installation	August 5 – 16
• Advanced Photovoltaics	August 19 – 30
• Solar Home Design	September 16 – 27
• Environmental Building Technologies	Weekends – September

Call for a complete schedule.

Solar Energy International

Renewable Energy Education and Sustainable Development

BOX 715, CARBONDALE, COLORADO 81623
(970) 963-8855 • FAX (970) 963-8866
e-mail: sei@solarenergy.org



The Midwest Renewable Energy Association Workshop Schedule

MREA is a grass-roots, non-profit educational organization whose mission is to promote renewable energy and energy efficiency through education and demonstration.

Membership and participation in the MREA are open and welcome to all interested individuals and organizations.

SUMMER...

Help install the photovoltaic and wind systems that will power this year's **Midwest Renewable Energy Fair**. (Students should have a basic knowledge of electricity)

June 11-19: PV Systems Design and Installation
Instructor: Jim Kerbel of Photovoltaic Systems, and Chris LaForge of Great Northern Solar
Location: Amherst, WI Cost: $300

June 14-16: Wind Systems Design and Installation
Workshop Co-Sponsor: World Power Technologies
Instructor: Mick Sagrillo of Lake Michigan Wind & Sun
Location: Amherst, WI Cost: $100

FALL...

September 7-8: Wind / PV Hybrid Systems
Instructor: Mick Sagrillo of Lake Michigan Wind & Sun
Location: Amherst, WI Cost: $200

September 13-14: Edible Landscaping & Organic Gardening
Workshop Co-Sponsor: Minnesota Landscape Arboretum
Instructors: Nancy Rose, Research Horticulturist, and Jean Larson, Coordinator of Therapeutic Horticulture – MN Landscape Arboretum.
Location: Minnesota Landscape Arboretum, Chanhassen MN, and Larson Farms, Princeton MN Cost: $50

Sept 20-22: A Place to Call Home: A Soulful Look at Alternative Building Techniques
Instructor: Mark Morgan; Builder / Philosopher
Location: Beaver Creek Nature Preserve, Fall Creek, WI Cost: $250

Sept 27-29: Energize Your Home or Classroom
Workshop Co-Sponsors: Central Wisconsin Environmental Station, and Wisconsin Center for Environmental Education.
Instructors / Facilitators: Tehri Parker, MREA, Kurt Nelson, SOLutions, and others
Location: Amherst Junction, WI Cost: $120

October 11-13: Introduction to Renewables & Photovoltaic Systems
Instructors: Chris La Forge, Great Northern Solar
Location: Duluth, MN Cost: $250

November 9-10: Energy Efficient Construction Techniques
Instructors: Mark Klein & Jim McKnight of Gimme Shelter Construction
Location: Amherst, WI Cost: $200

November 16: Practical Solar Design for Architects & Engineers
Instructors: Doug Steege of Altech Energy
Location: Madison, WI Cost: $100

Call or write for more information and course descriptions.

The Midwest Renewable Energy Association • PO Box 249, Amherst, WI 54406
phone (715) 824-5166 • fax (715) 824-5399

HAPPENINGS

AFRICA

Needed: PV Volunteers for Africa. Solar Energy International (SEI) is organizing volunteers trained in the design and installation of small stand-alone photovoltaic systems. This pilot program, a component of SEI's INVEST Program, provides selected volunteers with an opportunity to work with small African businesses and community groups. Participants will work under the direct supervision of Energy Alternatives Africa (EAA). The EAA is a leading African organization promoting PV rural electrification.

To support this charitable program, volunteers must make a one year commitment and be responsible for paying 50% of their travel and in-country expenses. The total amount a volunteer needs to provide for the entire in-country year is approximately $5,000. The other 50% will need to be raised by SEI and EAA.

Potential volunteers are required to successfully complete SEI's PV Training program (or equivalent) as a prerequisite. The full four weeks of intensive technical training will cost each participant an additional $1700 for workshop tuition. Volunteers have two opportunities to complete the required training this year: May 28-June 21 or August 5-August 30.

To find out more about EAA please see Home Power Magazine issue #41. For background information about SEI please see Home Power Magazine issues @21, 31, 32, 49 & 50.

Solar Energy International, PO Box 715, Carbondale, CO 81623, 970-963-8855, Fax 970-963-8866 • e-mail: sei@solarenergy.org; Web: http://solstice.crest.org/renewables/sei/index.html

AUSTRALIA

Race with the Sun across the Australian Outback 1996 World Solar Challenge. Come join Team New England in the Australian Outback for three weeks of solar car racing beginning mid-October as they enter the 4th World Solar Challenge, the toughest race of its kind in the world. For $10,000, Team New England will provide you with round trip airfare to Australia, all meals and lodging across the outback during your entire stay and a once in a lifetime chance to vie for the World Championship. Your name will appear on Team New England's solar car entry along with their corporate sponsors. You will take part in all events surrounding the race along the 3010 km route as a guest member of Team New England. Sunglasses are mandatory. No cry babies allowed. For more information please contact: Team New England, Alan Rux—UML Electrical Engineering, One University Ave, Lowell, MA 01854, 508-934-3330 (message phone), 508-934-3061 (team fax), e-mail: GarrisonS@Woods.UML.Edu. Your $10,000 contribution is tax-deductible.

CANADA

A Sustainable Future: How Do We Get There From Here? A conference retreat sponsored by the Solar Energy Society of Canada Inc., June 9-June 12, 1996. This three day retreat will focus on topics that are key to the success of a sustainable energy future: policy options, technical developments, commercialization, and required action. For more information contact Solar Energy Society of Canada Inc., 250-2415 Holly Lane, Ottawa, ON K1V 7P2, Canada, 613-523-0974, Fax 613-736-8938, e-mail: solar@worldlink.ca

The "Alberta Sustainable House" is now open for public viewing every Saturday 1:00-4:00 PM free of charge. The first of its kind in Canada, the project emphasizes cold-climate state-of-the-art features/products based on the founding principles of occupant health, environmental foresight, resource conservation, AE, recycling, low embodied energy, self-sufficiency, and appropriate technology. Already in place: R17 windows, multi-purpose masonry heater, solar hot water, greywater heat exchangers, LED and electroluminescent lighting, solar cookers, and others. Under development: hydrogen fuel cells, Stirling co-generator, Tesla bladeless steam turbine, and others. Contact: Jorg Ostrowski, Autonomous & Sustainable Housing Inc/Alternative & Conservation Energies Inc, 9211 Scurfield Dr NW, Calgary Alberta T3L 1V9, Canada; 403-239-1882, Fax: 403-547-2671

The Institute for Bioregional Studies was founded to demonstrate and teach recent ecologically-oriented, scientific, social and technological achievements that move us toward ecological, healthy, interdependent and self-reliant communities. For more info: IBS, 449 University Ave, Charlottetown, Prince Edward Island C1A 8K3, Canada; 902-892-9578.

GERMANY

"Bayern Solar 1996" to be held 19–21 July. Rally around Lake Cheimsee in Southern Germany (Bavaria) using electrically powered vehicles in four different classes. For details or more information contact Mr Werner Hillebrand, Weldenstrabe 19, 85356 Freising, Germany. Tel. 49-8161-871148 Fax: 49-8161-82848.

PHILIPPINES

The 3rd International Renewable Energy Asia Pacific '96 (REAP'96) Exhibition and Conference will be taking place in Manila, Philippines, October 1996. This three day event for both the conference and exhibition and is dedicated to Solar Photovoltaics & thermal, wind, biogas/biomass and hydro projects in the Asia Pacific region. The conference will focus on marketing strategies, project financing , policies and incentives for the implementation of renewable energy projects in the Asian countries. Exhibitors will display their latest in renewable energy and energy efficiency products and services. For more information contact Michelle Hassall, Project Manager, 5/F 3 Wood Road, Wan Chai, Hong Kong. Tel: +852-2574-9133 Fax +852-2574-1997.

NATIONAL

Energy info on the Internet can now be accessed via the Energy Efficiency and Renewable Energy Network (EREN), a multimedia WWW server developed by the DOE. Check it out at http://www.eren.doe.gov or contact: Energy Efficiency and Renewable Energy Clearinghouse, PO Box 3048, Merrifield, VA 22116; 800-363-3732; e-mail: ENERGYINFO@delphi.com

American Hydrogen Association, national headquarters, 216 South Clark Dr, Ste 103, Tempe, AZ 85281, 602-921-0433, fax 602-967-6601, e-mail: aha@getnet.com "Prosperity Without Pollution" web site: http://www.getnet.com/charity/aha

Energy Efficiency and Renewable Energy Clearinghouse (EREC) is offering a free booklet, Audits?, Tax Audit (Oh NO!) Home Energy Audit (Oh Yeah!). To obtain free information on how to conduct a Home Energy Audit and start saving on your energy bills, contact EREC: Phone: 800-DOE-EREC (363-3732); mail: EREC, PO Box 3048, Merrifield, VA 22116; e-mail: energyinfo@delphi.com; TDD: 800-273-2957; The information can also be downloaded via the DOE's BBS at 800-273-2955 or via internet: http://www.eren.doe.gov

EcoMall, A Place to Help Save the Earth. http://www.ecomall.com • Eco Companies/Products • Daily Eco News • Renewable Energy • Eco Restaurants • Activism • Communications • Business to Business • Eco Data Bases. For more info, please call: (212) 289-1234 or write 75 Spring Street 4th Floor, New York, NY 10012. E-Mail: ecomall@internetmcl.com

Visit AWEA's (American Wind Energy Association) home page on the World Wide Web. (http://www.igc.apc.org/awea) Visitors to AWEA's home page can obtain information about the US wind energy industry, AWEA membership, small turbine use, and much more.

ARIZONA

The State of Arizona is now offering a tax credit for installation of all types of solar energy systems. A solar technician certified by the Arizona Department of Commerce must be on each job site. For info contact ARI SEIA; 602-258-3422.

ARKANSAS

Sun Life is now conducting "Third Saturday Seminars" on inexpensive building techniques. Their focus is to teach home building from materials that can last a thousand years and cost less than conventional wood-framing. These are hands-on, all-day workshops. Contact Loren at PO Box 453, Hot Springs, AR 71902.

CALIFORNIA

The Solar Living Institute 1996 Workshop Schedule: June 8—Planning and building your renewable energy home, June 9—Organic gardening & drip irrigation, July 13—Strawbale construction, July 14—Sustainable building & eco design, August 10—Realizing the Dream—planning & buying the perfect country home property & developing your homestead, August 11—Planning & building your renewable energy home, September 14—Strawbale construction, September 15—Planning & building your renewable energy home. Each day-long workshop costs $100 and includes a catered vegetarian box lunch. To register or for more info contact: Real Goods Institute for Solar Living, 555 Leslie St, Ukiah, CA 95482-5507, 800-762-7325.

The Grand Opening of the Real Goods Solar Living Center will be held June 21–23 at their new location in Hopland, CA. For more info contact, Karen Hensley, Real Goods, 555 Leslie St, Ukiah, CA 95482-5507, 800-762-7325.

1996 North American EV & Infrastructure Conference will be held December 11–13, 1996 in San Diego, CA. The Conference will provide up-to-date commercial and technical information to audiences of all levels. Marketing, government and business issues will be addressed, as well as technical advances made in battery, vehicle and infrastructure development. For more information contact EVAA, 601 California St Ste 502, San Francisco, CA 94108, 415-249-2690, fax 415-249-2699, e-mail: ev@evaa.org

Women's Earth Home Building Workshop, Mount Shasta, CA August 3–8, 1996. Learn about building your own home plus enjoy the alpine air, meadows, views, music, lake & fun on womensland! Contact: Groundworks, PO Box 381, Murphy, OR 97533, 541-471-3470 or Nani, PO Box 133, Weed, CA 96094, 916-926-6121

COLORADO
Solar Energy International (SEI) is offering "hands-on" workshops on the practical use of solar, wind, and water power. The 1996 Renewable Energy Education Program (REEP) features one and two week sessions: PV Design & Installation—May 28–June 7 & August 5–16; Advanced PV—June 10–21 & August 19–30; Solar Cooking—July 1–3; Microhydro Systems—July 8–19; and Wind Power—July 22-August 2. Experienced instructors and industry representatives teach how to build homes and RE systems. Learn in classroom, laboratory and through field work. The workshop series is for owner-builders, industry technicians, business owners, career seekers and international development workers. The small, intensive and fun workshops may be taken individually or as a comprehensive program. The cost is $550 per week. SEI is a non-profit educational organization dedicated to furthering the practical use of RE technology. Contact: SEI, PO Box 715, Carbondale, CO 81623 or call 970-963-8855, Fax 970-963-8866, e-mail—sei@solarenergy.org

Visit the new National Wind Technology Center operated by the National Renewable Energy Laboratory, just outside of Golden, CO. The facilities assist wind turbine designers and manufacturers with development and fine-tuning and include computer modeling and test pads. Call in advance, 303-384-6900, Fax 303-384-6901.

June 23–27, 1996 WINDPOWER '96 is AWEAs 26th annual conference and exhibition. This year's conference will be held in Denver, CO and will include a tour of the National Wind Technology Center. The conference will feature sessions on technical advances in the wind industry, current regulatory issues, the economics of wind power and more. WINDPOWER'96 offers industry leaders, consultants, academicians, regulators, legislators and wind power enthusiasts the opportunity to share perspectives and experiences and report on the latest industry developments. Contact: Linda Redmond, AWEA, 122 C St NW, Fourth Floor, Washington, DC 20001, phone 202-383-2500, fax 202-383-2505.

The US Department of Energy and its National Renewable Energy Laboratory will host the World Renewable Energy Congress IV in Denver from June 15–21, 1996. Conference topics will include photovoltaics, solar thermal, wind energy, biomass, energy efficiency, economics and institutional issues, global and regional economic development, and environmental issues. The latest in energy efficiency and renewable energy equipment will be on display. More than 200 speakers have been invited and 500 abstracts for technical papers been received. Abstracts are still being accepted. For more information contact Bob Noun, 303-275-3062; Professor Ali Sayigh 1734-611634(UK), or Steve Hauser, chairman of the technical committee 303-384-7416

IDAHO
The Solutions Group will be sponsoring its 4th Annual Renewable Technologies Fair in Sandpoint, Idaho on July 6th. The Fair focuses on products and suppliers for the Inland Northwest. The Fair will also feature an electric vehicle tune-up workshop as preparation for an electrathon race on July 7th. For more information: 208-265-0292.

IOWA
Fifth Annual I-Renew Energy Expo and Alternate Fuel Vehicle Showcase at Hawkeye Downs in Cedar Rapids, IA Contact I-Renew, PO Box 2132, Iowa City, IA 52244, 319-338-3200, fax 319-351-2338.

MICHIGAN
Sky View Farm, a solar and wind powered homestead, is offering six half-day workshops this summer (June 15 & 29, July 13 & 27, August 10 & 24). Each workshop will include an introduction to passive solar housing, solar and wind energy systems, domestic water heating and pumping, Permaculture, and rain water catchment. Participants will receive take home literature and sample system schematics. For more information contact David VanDyke, 314 West Valley Road, Maple City, MI 49664. Phone (616) 228-6433.

MONTANA
Sage Mountain Center, a Retreat and Educational facility, is offering Lifeskills Workshops during the summer. Dedicated to promoting deeper awareness of one's self and one's environment, this years theme is "Create Your Living Space". Workshops include: •6/15 Low Cost Earth Friendly Home Building •6/29 Solar Electricity •7/13 Making Log Furniture •7/27 Building From the Soul •8/17 Cordwood Construction. A harmonious blend of function, form, and economy is at the heart of these hands-on, one day workshops. $45 per person includes class, lunch, and literature. For pre-registration and details write Christopher Borton or Linda Welsh at Sage Mountain Center, 79 Sage Mountain Trail, Whitehall, MT 59759 or call 406-491-0954.

NEW YORK
Solar Energy International (SEI) is offering a special workshop for the convenience of Northeasterners who want to get their hands-on!

PV Design & Installation will be a one week workshop Monday October 14 through Saturday October 19. Instruction will be conducted at an off-grid location near Woodstock, NY. The workshop tuition cost for all six days is $550.

Workshop topics include: Solar site analysis, system sizing, PV modules, controllers, batteries, inverters and appliances, demonstrations, lab exercises and hands-on installation. No prior experience or training is required—everyone is welcome!

For more information contact: SEI, PO Box 715, Carbondale, CO 81623 or call 970-963-8855, Fax 970-963-8866, e-mail—sei@solarenergy.org • For local housing & logistical information please contact SEIs local co-sponsor: Larry Brown at Sun Mountain, PO Box 1364, Olivebridge, NY 12461, 914-657-8096.

The New York State Electric Auto Association (NYSEAA) is dedicated to sharing current electric vehicle technology. Monthly meetings, for date and location call Joan at 716-889-9516

NESEA Sustainable Transportation EV96, September 16–18, 1996, Madison Square Garden, New York City. The symposium will attract decision makers from the auto industry, transit bus industry, business, electric utilities, fleet management, policy makers agencies, electric vehicle component manufacturers, engineering and consulting firms, transportation planners, non-profits and universities who will share and network. An extensive trade show will showcase road-ready electric and hybrid sedans, pick-ups, vans and buses, as well as cutting edge concept vehicles and related components and services. Sessions will include: Advanced EV Technology, Hybrid EV Technology, Integrating EVs into Your Fleet, Fundamentals of Building an EV, Business & the EV Industry, Planning Sustainable Transportation, and Buses of the Future. For more information contact; NESEA. 50 MIles St, Greenfield, MA 01301, 413-774-6051, fax 413-774-6053.

OHIO
The Great Lakes Electric Auto Association's mission is to contribute to the freeing of the US automobile market from dependency on petroleum through advancements in electric and hybrid/electric technology. For more information: Larry Dussault, GLEAA, 568 Braxton Pl E, Westerville, OH 43081-3019, 800-GLEAA-44, 614-899-6263, Fax 614-899-1717. Internet: DUSSAULT@delphi.com

Solar and wind classes taught at rural solar and wind powered home with utility back-up. Maximum of 12 students. Must advance register. $40 fee per person, $45 per couple and lunch is provided. Please advise of dietary restrictions. Class #1 will be full of technical info, system design, system sizing, and NEC compliance, etc. Students will see equipment in use. Students may also choose class #2 and set-up a system (hands-on training), equipment selection, installation of modules, mounts, controller, inverter, and battery bank.

Dates: Jun. 15, Jul. 13, Aug. 10, Sept. 7, Oct. 5, Nov. 2, Dec. 7. All classes held from 10:00 am - 2:00 pm on Saturday. Call 419-368-4252 or write Solar Creations, 2189 SR 511 S, Perrysville, OH 44864-9537.

OREGON
APROVECHO RESEARCH CENTER offers 3 month training sessions in appropriate technology, sustainable forestry and organic gardening. Classes begin June, September, January (1 month in Mexico), & March. Daily

classes 8:30-5:30. Cost is $500.00 per month, includes room, board. For more info: 80574 Hazelton Rd., Cottage Grove, OR 97424. (503)942-8198

SOUTH CAROLINA
Green Village '96: The Southeastern Sustainable Communities Exposition, September 13–14, 1996 in Charleston, SC. For more information contact Jean-Paul Gouffray, South Carolina Energy Office, PO Box 21655, Charleston, SC 29413, 803-577-2103

TENNESSEE
Bioenergy '96, The Seventh National Bioenergy Conference, September 15–19, 1996 in Nashville, TN. (Geared toward industry and cities). For more info contact the host, Southeastern Regional Biomass Energy Program, Tennessee Valley Authority, CEB 3A, PO Box 1010, Muscle Shoals, AL 35662-1010

VERMONT
Free PV Workshops for beginners to experts given by David Palumbo of Independent Power & Light, First Saturday of every month at the Palumbo/IP&L PV and microhydro powered off-grid neighborhood. Participant interest will determine which of the following topics will be discussed and demonstrated (as practical): site selection, PV modules, batteries, charge controllers, inverters, lighting (ac & DC), balance of system components, system monitoring and maintenance, water (finding it, developing it, transporting it, pumping it, and getting power from it), snow (living with it, playing with it, and removing it), ponds, living in cold climates, living with our woods, heating with wood, and root cellars. Visit a beautiful part of Vermont and meet people who are either living with renewable power or considering it. David Palumbo has taught workshops in the past with the fine people of Solar Energy International and with the real good folks of the Solar Living Institute. Call, fax, or write for your reserved spot, information, and directions. 9am to 3 pm the first Saturday of every month. David Palumbo/ Independent Power & Light, RR1 Box 3054, Hyde Park, VT 05655, call or fax 802-888-7194. This is a freebie so bring your own lunch and coffee. We will supply our own pure drinking water, and a great pond for swimming if you are so inclined.

WISCONSIN
The Midwest Renewable Energy Association Spring Workshop Schedule. June 12–19: PV Systems Design and Installation, Instructors: Jim Kerbel of Photovoltaic Systems and Chris LaForge of Great Northern Solar, Location: Amherst, WI, Cost: $300. Help install the photovoltaic and wind systems that will power this year's Midwest Renewable Energy Fair. (Students should have a basic knowledge of electricity). Fees for pre-Energy Fair Workshops cover instruction, handouts, and camping at the Portage County Fairgrounds. June 14–16: Wind Systems Design and Installation, Instructor: Mick Sagrillo of Lake Michigan Wind and Sun, Location: Amherst, WI, Cost: $100. Sept. 21–22: A Place to Call Home: A Soulful Look at Alternative Building Techniques. Sept. 27–29: Energize Your Home or Classroom, Instructors: MREA Staff and others, Location: Central Wisconsin Environmental Station, Amherst Junction, WI. Cost: Please call MREA office. Learn more about energy conservation and renewable energy through experiments and demonstrations. Energy education activities, classroom projects, and curriculum ideas for grades K-12 and youth groups will be explored. Tour alternative energy homes in the area. Co-sponsored by the Central WI Environmental Station, Midwest Renewable Energy Association and WI Center for Environmental Education. 1 UWSP credit available. MREA is a grass-roots, non-profit educational organization whose mission is to promote renewable energy and energy efficiency through education and demonstration. Membership and participation in the MREA are open and welcome to all interested individuals and organizations. Significant others may attend with you for 1/2 price. For more information call or write MREA, PO Box 249, Amherst, WI 54406; phone 715-824-5166, fax 715-824-5399

The Seventh Annual Midwest Renewable Energy Fair will be held June 21–23,1996, at the Portage County Fairgrounds in Amherst, Wisconsin. Contact Midwest Renewable Energy Association, PO Box 249, Amherst, WI 54406, 715-824-5166.

the Wizard speaks...

Grab Bag

Here are a few short subjects which you might find interesting to consider.

Get The Paper Out
With the state of electronics today, it should be fairly easy to create an inexpensive electronic reader and associated storage technology. This would definitely reduce paper usage world-wide.

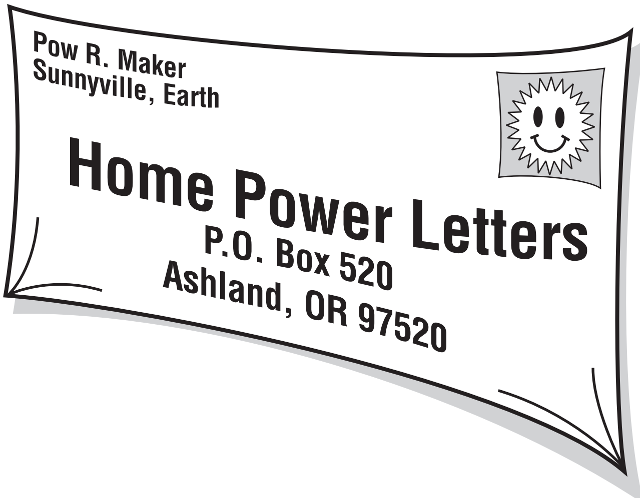
Bioluminescence
Consider the possibility of bioluminescent plants for lighting. They could store energy during daylight hours and give off that energy at night as light. We could have living solar light.

Nuclear Waste
Nuclear waste will eventually have to be stored in somebody's backyard, figuratively speaking. We should decide where and do it as soon as possible. Temporary storage is just an accident waiting to happen.

Reflection
The currents of the Earth reflect the currents of the Universe. Totality reflects totality. Every entity, from an atom to a galaxy, reflects the totality of the rest of the Universe.

Organic Loss
Today's technology removes massive amounts of organic substance from the biosphere. This reduces the ability of the biosphere to reproduce itself. Eventually, the biosphere will be reduced to a point where it will be unable to sustain human civilization as we know it.

That's all for now.



Wind Towers

Dear *Home Power* Crew, I just finished reading John Dailey's article on the tilt-up tower he built for his new Bergey 850 wind generator (HP #52). John did a nice job adapting local materials to solve his tower problem. And your graphic detailing of the tower configuration is truly great!

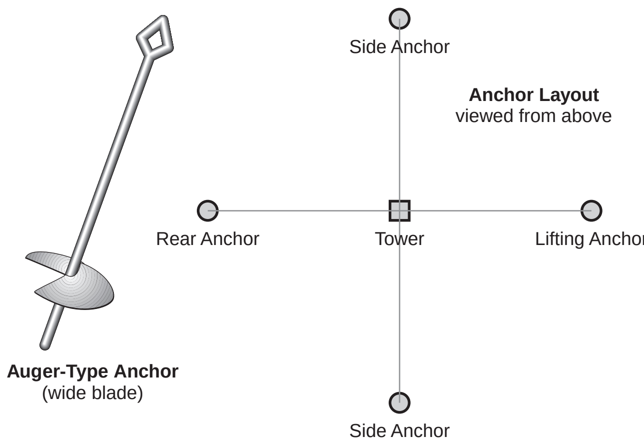
A few comments about some specific details, however, are in order. John states that he used auger-type anchors for the tower, as are specified by the companies that offer commercially built tilt-up towers (see accompanying diagram). The anchor in the diagram on page 27, however, is a corkscrew anchor, the type used to tether a dog on a leash. Corkscrew anchors have good holding power when you pull on them horizontally, as a dog on a leash would do. They offer little resistance when pulled from a near-vertical direction, as would occur with a tower tugging on its guy cables. Corkscrew anchors are never recommended for anchoring towers.

From his photo of the hinge arrangement, it appears that John used a piece of water pipe as the hinge pin. Water pipe is rather easily bent, as anyone who has ever wrestled with old plumbing can attest to. A suggestion is to substitute a piece of solid round bar for the water pipe.

The text and diagram on page 27 specify a stub tower "3 or 4 feet tall". Today's small wind generators all sport thin flexible blades. As a result, clearance between the blades and the stub tower is critical. The base plate and gussets of the stub tower must be beyond the reach of the tips of the blades. If your blades flex back and strike the gussets, the blades are not covered by the manufacturer's warranty. This can be a very expensive mistake!

Finally, a note on three- versus four-guyed towers is in order.

Fixed guyed towers that do not move, like TV or radio transmitter towers, are anchored to the earth at three points 120° apart, the minimum you can get away with. Tilt-up towers, however, must be anchored at four points, 90° apart (see accompanying diagram).



The three dimensional geometry of a three-guyed tilt-up tower is such that when the tower is between a 45° angle and horizontal, as it would be at the beginning of a lift or as it is being lowered, "down" for the tower is not straight down, but off to the side. The result is a long lever arm that will destroy buildings or people in it path. With a four guy system, this problem is eliminated. A simple model with a broomstick and some string will demonstrate the phenomena to the skeptical.

A three-guyed tower's propensity to fall to the side as it nears the ground has been a serious problem with do-it-yourselfers. We have acquired a number of folks as customers who have trashed their towers and wind generators trying to defy the law of gravity. Fortunately, no one has been hurt in the process.

There are several companies who manufacture and sell tilt-up towers for wind generators. In addition, several wind generator manufacturers offer plans for do-it-yourselfers. In all cases, these tilt-up towers and plans are for systems that are anchored in four places 90° apart. One manufacturer was supplying kits for a three-guyed tilt-up tower, but has since gone exclusively to a four-guy design.

Tilt-up towers are the best idea for small wind generators that has come along in a long time. Properly designed and constructed, these towers offer a safe alternative to climbing, while providing many years of service. This is what "home power" is all about! Mick Sagrillo, Lake Michigan Wind & Sun

Thanks for your comments, Mick. The tower we use here at Agate Flat is the four guy type. It has a Whisper 1000 on top. It lowers and raises like a dream in just a

few minutes with some help from our 4WD pickup in low range. Our soil here does not support any type of screw in anchor, so we used concrete pads to anchor the guys and tower. I feel that nothing is holding back small scale wind generators more than the lack of decent and affordable tower kits. Richard

Colorado EV Rebate

For well over a year now, the state of Colorado has offered attractive cash rebates to residents who purchase an alternative fueled vehicle, or who convert an existing vehicle to use an alternative fuel. This program has been motivated in part due to severe air quality problems in certain parts of the state.

Over one-half million dollars has been set aside to provide incentives for a switch to alternative fuels, including some funds from the Federal Department of Energy.

Strangely, 100% of the program activity to date has centered upon compressed natural gas and propane-fueled vehicles which, of course, still feature internal combustion engines and tailpipes.

Judging from documents and conversations with the Governor's Office of Energy Conservation (OEC), the program as originally envisioned definitely includes zero emission vehicles (electrics), but there have been no ZEV participants yet.

I asked why. The rebates get rolling only when a company which supplies the alternative fuel agrees to contribute part of the rebate. Companies who make such commitments are referred to as "matching parties" or "partners" in the program. No partner, no rebate, and so far no electric-fuel provider has taken part.

No doubt, this entire fuel provider/partner vernacular raises many questions and issues for those of us who own alternative energy generating equipment. Those individuals who are totally off-grid don't have any electricity provider other than themselves.

Even so, for those Coloradans who are customers of an electric utility, and who also wish to invest in an electric vehicle, some investigation and effort could pay off nicely. I believe a maximum rebate of $3,750 is possible for light truck owners. Unlike some other incentive programs, this is not a credit against income tax obligations, but an actual cash return to the vehicle owner.

In my own case, I use utility power as the back-up for my PV system, and I am on a time-of-use billing program which would permit nighttime recharging at relatively low cost. Easy to see why I called up my local utility (La Plata Electric) to ask them to take part in the alternative fuels rebate program!

Where solar power comes from

La Plata is a cooperative with a progressive outlook. First try I spoke right with David Potter, the company president, who told me they had never heard a peep about the rebate program, but would be interested to learn more. I gave Mr. Potter the name and number of the OEC, and La Plata made inquiry with them.

The program administrators were so enthused at finally having some interest expressed by an electric utility that they have offered to travel down to the Four Corners region to make a presentation to La Plata's board in Durango.

Meanwhile, La Plata has assigned the project to one of their employees who happens to be an electric car enthusiast himself. Bruce Sumner and I "talked cars" for half an hour today.

Who knows where this will wind up? Those who plow new ground should plan on hitting some rocks. Besides working on the bureaucratic and corporate fronts, interested parties need to decide on the vehicle or conversion that's right for them. Conversion installers may become certified under the program, and some of us who are battery nuts anyway may wish to become installers or vehicle re-sellers.

To learn more, Coloradans should call Lisa Nelson at the Governor's OEC: 303-620-4292. Then go to work on your local utility. The first EV rebate will be the toughest to achieve, but may open an important door.

When the people lead, the leaders will follow! Mick Abraham, 124 Creekside Pl, Pagosa Springs, CO 81147

All right, Mick! Thanks for the info and I hope our readers in Colorado will take advantage of this rebate to help them drive electric. Richard

From EVs to PVs

A friend recently gave me the February/March 1996 issue of *Home Power* because of my interest in electric vehicles. However, after only seeing this one issue, my wife and I are very excited about the possibilities of other home made power projects. So, we are hooked. Dave Biser, Hagerstown, MO

Hello Dave. The technology for making electricity at home using renewable energy sources is here now. We have thousands of readers, all around the world, who are doing just that—making their own power using the sun, wind and falling water. Most of these systems cost far less than a new car, will last far longer than a new car, and are better for the planet than a new car. It's just a matter of time until everyone figures out that electricity can be homegrown just like vegetables. Our job at Home Power is to hasten this day. Richard

Utility Bashing

I am always disturbed by reader's & publisher's negative, and almost "bitchy" comments about the Utilities that have to produce unbelievable amounts of electricity for the Public, a Public that doesn't know a watt from a BTU, but demands consistent power. Otherwise I like everything about your mag—even the articles that make me uncomfortable. Alex Majeski Jr, Krakow, WI

Well, Alex, I'll admit to being no friend of Redi Kilowatt (or should that read Redi Killerwatt?). In just this issue alone we have specific examples of my gripes against utilities. For just one, check out Daniel Whitehead's article starting on page 6 of this issue. Daniel and Lori Whitehead pay their utility 10.5 cents per kiloWatt-hour for the electricity they consume from the utility. The utility, however, pays Daniel and Lori only 1.7 cents per kiloWatt-hour for the wind power they sell to the utility. I think that this is a raw deal. Why is the utility's energy worth six times more than the Whitehead's energy? The utility has no capital investment in the Whitehead's system. The power made by the Whitehead's system is of the finest kind—renewable, no pollution, no carbon dioxide, no waste of any kind.

To be sure the utilities have their expenses. Roughly half of the money spent by America's utilities is spent on transmission—building and maintaining power lines and distribution lines. I know that utilities will continue to exist as power brokers for many years to come. But the utilities must come to realize that their century long monopoly over electric power production is over. Utilities must come to value clean RE input from small scale RE systems—they should pay more for this power because it is worth more than power from say a nuke plant.

You live in Wisconsin which has a very atypical utility situation. Wisconsin has dozens of small utilities, municipal utilities, and rural electric coops. These small utilities are very responsive to the demands of their rate payers. Contrast this with say Northern California which is serviced by a single utility—PG&E, the largest investor owned (read that as "for profit") utility in the world. When California Senate Bill 656 passed recently it gave net billing to parity to small-scale PV systems who were utility intertied. It was due to PG&E's lobbying that small scale wind and hydro system were excluded from this bill. We must realize that investor owned utilities are in the power business to make money. Having their monopoly on power production challenged is a threat to profit. They will only properly value our RE input if we force them to.

While we are on the subject of money, let's talk about abusing our planet for profit. If the damages were factored in, then RE is now (and has been for some time) cheaper than than say coal, nukes or even natural gas. The only problem from the utilities' perspective is that RE is not concentrated, but democratically delivered to everyone everywhere. Utilities wish to keep the status quo—big scale centralized energy production. This way they can make power and you can rent it. The idea of having you make your own power scares the beejebis out of them—it means that you don't need them anymore. If this idea gets around, then the bottom line is going to suffer. And we can't have that, now can we?

Just let me say that some of my best friends work for utilities. In fact, my brother Michael has worked for the municipal utility in San Antonio, Texas for almost twenty years. We argue about this all the time. Utilities are made up of people who make and deliver power. Folks who are, as individuals, just like us, with the same hopes and fears. It's when this issue disappears into the corporate boardrooms that I begin to tremble. All us home power types ask is equal seating at the table. Richard Perez

More Refrigerator Help

Am kind of late in responding to a letter in issue #51—mail is slow to reach us on the road where we live full-time in our motorhome and I am slow in getting things done now that I have retired from a high-pressure job.

Susan Pettijohn asked about a manual for an older

Dometic refrigerator and books on absorption-type refrigerators. She should check RV stores, particularly Camping World. There have been several books published on RV service and maintenance that cover the theory of absorption refrigeration as well. Trailer Life Publishing Co. has published several and often they focus on Dometic since it is such a common RV product.

Solar power is sure coming on strong with the RV crowd, particularly the “boondockers” of the SW deserts. We run 3-M55s into a couple of Group 24’s that came with the coach. We use a 5.5 kW generator for microwave, coffee maker, and air conditioner. We are conservative in power use and never have batteries not come back to full charge every day, even when cloudy. We spend the winter in Southern Arizona and summer in the Pacific NW, mostly Oregon where we both were born and lived all our lives until retirement.

I find *Home Power* fascinating even though we have a simple system that probably won’t be significantly enlarged. The self-sufficiency aspect is the real attraction, I guess. Thanks for the great magazine. Particularly like the person-to person style on answers to letters and technical inquiries. Tom Edwards, Salem, OR

Hello Tom, check out Rob Magleby’s article on page 24 of this issue. To those who know how to squeeze a watt-hour, one or two PV modules can do it all. Even part time RVers should have a small PV module to keep their batteries fully charged. Richard

Even more Refrigerator Help

I see that Susan Pettijohn is having a problem with an old Dometic Fridge. I am not an expert on such matters but a friend gave me an old, small Dometic unit out of his RV a few years ago that I use at a cabin in the mountains. I had a lot of problems getting the unit to run. I was finally told to turn the fridge upside down for 24 hours and then turn it over again and it would run. And so it was, it seems that the old units get a sort of vapor lock when left unused for a period of time. Each spring I have had to go through the upside down routine to start up the Dometic after being off for a number of months. It does not seem to make any difference if you use the electric or propane heating unit—same problem. At the cabin I use propane etc.

More recently another friend who knows a lot about refrigeration told me that a simpler way to get an absorption type refer going is to place a large block of ice in the freezing compartment and turn the unit on. He said that this would start the cooling cycle working again. I have not tried this method but if it works it is sure easier than the upside down routine.

On another matter, I am looking for a simple electronic circuit to turn on and off a small 12 VDC 13 watt security night light. There are larger commercial units that handle many amps but I am looking for a simple, inexpensive, low power unit or circuit. Bill Wilson, Moscow, ID

Well, Bill if you are into homebrew, then you could adapt Bob Morris’s circuit on page 32 to your use. Eliminate the input diode bridge (you already have low voltage DC), invert the logic, and instead of the LEDs as a load simply connect your security light via a relay (or transistor). Richard

35 Years of Dabbling

At this time I would like to congratulate you on a very informative magazine. And of course renew my subscription to your fine magazine. Thank you for not swamping me with renewal notices as many of the other magazines that I subscribe to do.

I have read your magazine sporadically for the previous four years and last year I finally subscribed, so that I wouldn’t miss an issue. When you went to glossy format, I thought, here goes another magazine losing concept and going down the tube & joining the Madison Ave. hyperbole, gag, choke, gasp concept.

After 35 years of dabbling and playing with renewable energy, I have almost obtained my goal of being totally RE. No, I am not hooked up to the grid, but I still have to use my 6.5 Kw generator for my shop toys, (mig welder, chop saw, etc.) My first PV module was brought in 1973, solar hot water 8 years prior.

My motor home has been totally solar electric since 1983, what a trial and error process that has been experimenting with various battery types, homebrew charge controllers and inverters. Some worked and others left a lot to be desired as they went up in smoke, literally and actually.

When I bought my property in Arivaca, Arizona and retired, I inquired about being hooked to the power line 2000 feet away and was quoted $4,000.00 + for the privilege of receiving a monthly power bill. When I mentioned going all solar I was hit with a ton of negative garbage about solar. Now about 8 months ago this same utility is offering to lease you a solar package for remote locations, my how the power of education works.

The next project will be a rammed earth building. Do you have any info on rammed earth or at least tell me what books contain useful information to accomplish this. So many books that I have seen, seem to have fancy covers, large type and very little info on this subject. No, I don’t want to hire an architect. As being

an avid do-it-yourselfer I have designed and built and sold 8 houses that conformed to all standard building codes, the houses ranged from 800 square feet to 1,900 square feet not counting the usual 25 X 30 shop (Gotta keep my play toys out of the weather). Concept, shop first, house later. Carl Martin, Arivaca, AZ

Hello Carl. We just received a new book for review. It's called The Rammed Earth House *by David Easton (ISBN 0-930031-79-2). I've not read the book yet, but it may answer your questions. Richard*

Pulsed Batteries
We are among the victims who purchased Hungarian nickel iron batteries. We have replaced most of our system with a set of L16s. However, I decided to try an experiment. I had a pair of Trojan T10s, 4 years old which had been sitting in the corner for 2 years. Those batteries were DEAD, totally sulfated. The electrolyte readings were approximately 1.05.

I connected these batteries to a Siemens 75W panel and a 12V "DuraPulse" and gave them three charges to 15V+ followed each time by a 100 Ah + discharge. Finally I gave them a long equalizing charge. Electrolyte readings were then 1.27 in all cells.

These batteries with the DuraPulse have been used for the last 6 months in a small sub-system (RF-12 SunFrost, Shurflow water pump and a few 12V lights). They have been working flawlessly

Richard, could you please, as you have promised, discuss electronic pulse systems in a future article? Sam Russell, Craftsbury Common, VT

Hello Sam. Well, in my experience the pulse charging technique really works. I have written articles about pulsing small sintered plate NiCd cells in previous issues. The only problem we are having is very high failure rates among the devices sold to pulse batteries. Until there is a durable commercial product, there will be no articles coming. Right now, Jerome at Mainline Electric is working on a commercial circuit that will provide the beneficial pulses and not fry and die in the first few months. Stay tuned, often these Tech Adventures take time and experimentation…. Richard

Extremely Nice
I am a private pilot and over the years, everyone that I have met in flying has been extremely nice. Thus elevating them and their chosen love (flying) above the average group of people.

Very happily, I have found the same with alternative energy people. And especially so with *Home Power* and Backwoods Solar Electric. Actually the people are so nice and humanistic, it would actually lead one to believe that there might be hope for the nation. You actually make a person want to stand to his feet; lift his eyes towards heaven and scream; "God Bless America". Patrick Swiney, Atmore, AL

Thanks for the flowers, Patrick. I agree, you will not find a finer group of folks than those involved with renewable energy.

Hemp Products
Ooops! My label say it's time to renew. Thanks for the great magazine. My other favorite magazine, *Hemp World*, just turned me on to the Ben Drucker's Hemp Flax company in Holland. They are making renewable building materials from hemp, not trees. You can see them on the web at http://hempworld.com. They show where alternative energy and environmentally safe products can come from hemp. How convenient! It's no wonder *Home Power* and *Hemp World* are the top magazines on my list. Thanks for the great ideas, sources and applications. Alan Silverman, Santa Rosa, CA

Hydronic Greenhouse
I want to thank you for all the good information and the clean, clear presentation of your magazine. It's encouraging to see the progress and innovation of the many individuals working with renewable energy. I know from personal experience it takes a lot of money, effort, and skill to design & install a simple 800 watt PV system. This Fall I intend to install hydronic heating in 1000 sq ft of raised beds in the greenhouse for early season, organic tomato production. I would appreciate letters from anyone who has done this, or could provide design help with solar preheating (80°+) in February in Olympia, WA. Douglas Hiatt, Shady Grove Organic Farm, 11746 Tilley Rd S, Olympia, WA 98512

How about it, readers? Richard

Where Are You
This is a very interesting magazine. I look forward to each issue. I wish there were more RE users in my area. Maybe there are and I don't know of them. Maybe there is some kind of bulletin board or at least a list of subscribers to your publication that would inform us of each other. Is there an RE fair in the Northeast? By investing in RE technology I hope to do my part in spreading the philosophy. I'd like to see windmills on top of high tension line towers as boosters to offset line losses, I'd like to see/need a life cycle analysis of the photovoltaic cell. Is the production of cells environmentally friendly? What about disposal of manufacturing by products? What does the future hold for development of lower cost and higher efficiency cells? How long do cells last? What happens to them afterward? Keep up the great work. Andy Nazar, PO Box 83, Shutesbury, MA 01072

Hello, Andy, we printed your address so that readers in your area can contact you. We do not publish or sell our mailing list. This is a decision we made on HP issue #1 and are sticking to. You will get no unsolicited mail from us. I'll see about working up an article on your PV questions. Basically the manufacture of PV cells is little different from the making of any semiconductor. If the maker is a slob, then there is a real danger to the environment. If the maker runs a clean scene, then there is almost no danger (barring accident). PV cells last at least 20 years these days, as the manufacturer's warranties indicate. Theoretical quantum efficiency for a single silicon PV junction is about 26%, so look for improvements in lower price rather than higher efficiency. Commercial modules now have between 9% and 18% conversion efficiency. After a cell is done, simply crunch it up and return it to the earth from which it came. Richard

Less Pragmatic

I'd like to see more on hydrogen generation, storage and use. On the EV front I'd like you to be more pragmatic and less politically polarized. I submit that a commuter car powered by an Orbital Engine, 2-stroke, getting 80+ mpg, burning ethanol, and meeting '97 California ULEV, is a better solution than packing around a thousand pounds of additional toxic waste. It is also more appealing to consumers! Once the battery problem is solved for real, we can move to EVs. Clint Snyder, Loveland, CO

Survival

First keep up the good work. It has been a rough winter for all of America. However, my photovoltaic modules survived 2 feet of snow, 50+ mph winds, and sub 0°F temperatures. My family and I are very proud of our system, and had a comfortable winter in spite of Mother Nature's best efforts here in New York. The Jamesons, Penn Yan, NY

You bet, it was a hell of a Winter. We've gotten many letter from readers whose RE systems were doing fine when the heavy weather had knocked out grid electricity. Here at Agate Flat we had four feet of snow and were snow in (no vehicle access) for almost two months. The only thing we didn't run short of was electricity. Richard

Blackouts

Due to a job transfer, we have moved to a new location that is on the grid. In the past two months we have had about 15 hours of electrical blackouts. Since we did not sell our stand alone PV electrical system when we moved, it will be reinstalled soon to provide back-up power. Our current residence location is on a north slope and does not have sufficient solar exposure to run the residence with the solar panels we now own. Hopefully we can find a better location soon.

During the four years we were "off the grid", Home Power was essential to us in providing information and knowledge needed to safely and economically purchase and use solar electric power. We avoided the many expensive lessons many of our neighbors learned the hard way and were able to assist them on the right path to solar power.

I am well satisfied with *Home Power Magazine*. Keep up the good work, I know it is a labor of love and does not provide a major financial reward. Thank you. Terence D Farrelly, Santa Margarita, CA

Thanks for the flowers, Terence. If the magazine keeps grits on the table, then the crew is happy. If we wanted to be rich, we'd work for the power company.... Richard

Disappointed

I've been a subscriber for five years and I really appreciate your efforts in blending technology with sanity. I wish you continued success. And a Disappointment. I bought your CD ROM but am unable to unzip any file via Window '95. The documentation is scant and the product is not what I've come to expect from *Home Power*. I wish it would work as I would like all back issues. But since it doesn't I would hope Home Power would fix the problem. Bill Hennessy, Mertztown, PA

Sorry that the CD-ROM wouldn't play on your system, Bill. Send it back and we will give you a complete refund. Solar 1 was a first attempt on our part. We had no idea that the demand for this info would be so great. We've learned much from the problems with this ROM. Solar 2 will be much better and will be readable on any Macintosh, IBM PC, or UNIX system. We will be using the new Adobe Acrobat Portable Document Format (PDF) which will provide full color, high resolution output that will look just like the pages of Home Power. With any luck we will have Solar 2 available before Christmas. Richard

Classes

I would like information regarding where I might go to take classes in the field. To my knowledge there is little consciousness about renewable power in the Northeast and I am relying on sources from the West Coast and Southwest to keep me abreast of developments in the field. Any leads on training (as a possible career) would be appreciated. William Palumbo, Tom's River, NJ

Hello William. Your best bet for RE education leading to an actual job is Solar Energy International. Proof of this is the fact that we (at HP) hired an SEI grad (Ben Root) last fall. Most RE installing dealers are small operations.

They cannot afford the time or manpower to train you in the basics. Completion of courses (like Basic PV and Advanced PV) at SEI can make the difference between being hired or not. If you can't afford the time or money for these one to two week SEI courses, then much of the same material is available in a shortened version from the Midwest RE Association's workshop series. The businesses I talk to give preference to those who have actually lived on RE systems. So the best place to start is at home (so, what else is new?). Richard

No Subsidies
I think this should answer what we think of *Home Power*. We still have every issue. Considering we live in a travel trailer we have to give away anything not needed. I am very conservative and do not believe government should help any source of energy over another. Know that runs against your feelings but major content of *Home Power* is so good I'm willing to overlook that. Keep up the good work. Lester Rose, Deming, NM

Hello Lester. I think you have me wrong. I would like to see all energy subsidies vaporize. What I object to is the government subsidizing utilities and paying environmental effects of commercial power from general taxes, while giving RE lip service. If all the subsidies and concealed expenses of commercial power were made manifest on everyone's power bill, then we would all be going RE tomorrow. It's this deception (mostly smoke and mirrors) that I object to. If the government insists on subsidizing utilities, then it should do the same for RE. Better yet, eliminate all energy subsidies. I have no doubt that the marketplace will choose RE. Richard

Simplicity
I haven't found anything in the magazine that I don't like. What I do like is the simplicity in technical explanations. I am a material science engineer who had to study the materials behind solar cells and text book explanations to how they work. It was always confusing until I read *Home Power* (can't remember which issue).

I can't wait until my family is free of the grid. We currently have a two bedroom vacation mobile home in Southwestern Colorado that is solar electric powered. We hope to make this our home in 3–4 years. *HP* has been a big inspiration in this decision. Keep up the good work. I would like to see more info on passive solar architectural design for cold weather climates (trailer is at 9100 feet). Gary, Amy & Jessica Williams, Phoenix, AZ

Well, Gary, Amy & Jessica , we do our level best to keep the techie stuff understandable by anyone who stayed awake during high school Physics. I very pleased to hear that this is working, thanks for the flowers. I owe many thanks to my high school Physics teacher, Mr. Walter Novak of Portsmouth (New Hampshire) Senior High—Uncle Wally taught me that if you understood basic Physics, then you could figure anything out. Except for affairs of the heart, he has been right.

We are trying to get more info for HP on solar thermal applications. We are hampered because we are electrical nerds, and don't have the familiarity on thermal applications required to deliver a clear and factual articles. We need help! Any thermal experts out there who want to help out? We're ready to run a regular thermal column in HP. Richard

A Guide
I'm an Appropriate Technology major at Appalachian State in Boone, North Carolina. Many of my classes include articles from *Home Power*. Your magazine is an invaluable research, reference guide for those of us making alternative energy our life!. Thanks & keep up the good work!. Scott Suddreth, Boone, NC

Aw shucks, we are happy to help and flattered that our attempts should be considered course material, Scott. You can be sure that we will keep the info flowing! Richard

Small Wind Generator Needed
Dear *Home Power*, We are ardent readers of your magazine for the past few years. We are working on a project to construct a small wind generator but have been unable to find a suitable generator. We have tried various motors but none worked to the minimum we expected. The wind speeds in these parts is about 3-8 m/s for much of the year and the blade-size is 1.25m so we expect to be able generate about 70watts of power on a given day. We need your assistance in locating a suitable manufacturer who can supply a generator with the following characteristics: 50-150 R.P.M., 6-15 VOLTS, 2-8 AMPS, and 50-100 WATTS.

Please help us in whatever way you can. If you can supply e-mail addresses of suppliers, it will help a lot. Phone/fax is expensive from here (India). We are looking forward to hearing from you or your readers soon. Thanking you, Saumya Bableshwar, Sri Aurobindo Ashram PO, Pondicherry 605002 India • e-mail: kim@auroville.org.in

Hello, Saumya. I don't know of a suitable generator, but I'll print your letter with your access and maybe one of our readers can help you out. Richard

Writing for *Home Power* Magazine

Home Power is a user's technical journal. We specialize in hands-on, practical information about small scale, renewable energy systems. We try to present technical material in an easy to understand and easy to use format. Most of our articles are written by our readers. Here are some guidelines for getting your RE experiences printed in *Home Power*.

Informational Content
Please include all the details! Be specific! We are less interested in general information, than in specific information. Write from your direct experience — *Home Power* is hands-on! We like our articles to be detailed enough so that a reader can actually apply the information. Please include full access data for the makers of equipment mentioned in your article. *Home Power* readers are doers. They want access data for the devices and products you mention in your article.

Article Style and Length
Home Power articles can be between 350 and 5,000 words. Length depends what you have to say. Say it in as few words as possible. We prefer simple declarative sentences that are short (less than fifteen words) and to the point. We like the generous use of Sub-Headings to organize the information. We highly recommend writing from within an outline. Check out articles printed in *Home Power*. After you've studied a few, you will get the feeling of our style. Please send a double spaced, typewritten copy if possible. If not, please print.

Editing
We reserve the right to edit all articles for accuracy, length, and basic English. We will try to do the minimum editing possible. You can help by keeping your sentences short and simple. We get over three times more articles submitted than we can print. The most useful, specific, and organized get printed first.

Photographs
We can work from any photographic print, slide, or negative. We work best from 4 inch by 6 inch color prints.

Line Art
We can work from your camera-ready art. We can also scan your art into our computers, or redraw it via computer. We usually redraw art from the author's rough sketches. We can generate tables and graphs from your data.

Got a Computer?
We would like your article's text on 3.5 inch computer floppy diskette if possible. This not only saves time, but also reduces typos. We use Macintosh computers. Please format all word processor files in "TEXT" format. We can also read text files on 3.5 inch IBM disks (720 KB, 800 KB, or 1.4 MB). Please format the IBM word processor files as ASCII TEXT.

You can send your article via modem to either the HPBBS at 707-822-8640 or via Internet. HPBBS address is: richard perez • Internet address is: richard.perez@homepower.org

Want your material returned?
Please include a stamped, self-addressed, return envelope, or box. Otherwise your material will not be returned.

Copyrighting
If you request it, we will copyright your work in your name. Otherwise we will copyright the information in *Home Power*'s name. The copyright on your material is yours for the asking.

Got any questions?

Give us a call. This saves everyone's time.

Access

Home Power **Magazine**
PO Box 520, Ashland, OR 97520 USA
916-475-3179 voice or FAX
Internet Email via:
richard.perez@homepower.org

Q&A

Energy Storage

First, I really appreciate the wealth of information given in *Home Power*.

I'm been working in Africa for thirteen years on development projects. With the savings I made on my salary I bought a small property in Portugal (off-the-grid) and in five years I hope to start living there on this farm. I've already built a house but I have not solved the energy problem yet. A mixture of solar and wind power will probably serve me best.

My question is about the energy storage. I found out that batteries will be a huge part of the total expenses for the system, so I started thinking about alternatives.

My home is situated on a hill side near the top and I will construct an irrigation tank near the house. In the valley (about 90 feet lower) the possibility for a pond exists.

Maybe it's a ridiculous idea but wouldn't it be cheaper pumping up water to the irrigation tank, from the pond, for instance with solar energy, when it's available, and using this water to generate electricity when needed with a hydro unit? So, the irrigation tank can serve as a "battery" which stores kinetic energy, available on demand.

Do you know of someone who tried this system before, and if so, did it work out?

If you think this is a stupid idea, please tell me, I'm not qualified in energy matters and am just thinking loudly. Jan Arie Nugteren, Burkina Faso, West Africa

Hello Jan. You are not the first to consider using pumped water as energy storage. In fact big utilities like Pacific Gas & Electric, do exactly that. The efficiency of pumped water energy storage is less than a battery. A battery is generally between 75% and 85% efficient. The pumped water scenario is much less than 50% efficient. Batteries are also cheaper than the pumped water scenario. In most systems batteries account for between 15 and 20% of the overall system's cost. I think that the pumped water scenario will be far more expensive to implement. Richard

Battery Switching

We have been receiving your great *Home Power* Magazine since "day one". We were fortunate enough to be on your mailing list when you printed your first magazine and we have received every issue since. We were so impressed with your first few issues, which were free, that we sent you donations encouraging you to continue publishing this wealth of information. As a result we were fortunate enough to be given a lifetime subscription which is very much appreciated as we are both retired and on a fixed income.

We started in 1978 producing our own electricity. Like you & so many other people we started by jumping power from our Toyota Land Cruiser, then to a small home made generator to a small home-made windmill and today we are blessed with 16 Kyocera K51 solar panels with all the fixings such as a Trace Inverter, Bobier Sun Selector, 1132 Amp hour lead acid battery pack, pus a 600+Amp Nicd battery pack.

This NiCd battery pack brings me to the real reason why I am writing this letter. At present I switch from NiCd to lead acid with an "on & off" throw switch and of course when I do this I have some arcing as well as resetting different monitors and memory systems, which is undesirable. My question is: Is it permissible to use an "anti-arc" type switch such as the Perko 350 Amp switch which would put the positive cable in common, momentarily, with both battery packs? If this is not desirable do you have any suggestions?

Keep in mind both battery packs have the same common negative but the positive cable to each is isolated through this switch.

Out of curiosity I would like to know what the consequence would be and what takes place if these two different packs were on the same positive cable. I know it can't be done but I don't know why.

The reason I have the two different battery packs is that I can charge the NiCds when we have an abundance of sun as they will hold the charge for a long period of time with a minimum of self discharge. Therefore when we have long periods of little sunshine we can call upon these NiCds to keep us going without starting up a generator. Harry & Grace Cole, Bridgewater Corner, Vermont

Hello Harry, go ahead and use the anti-arc switch. If both batteries are momentarily connected in parallel, then current will flow from the battery with the higher voltage to the battery with the lower voltage. Net effect is a momentary discharge of one battery into the other. This will not damage either battery. Consider adding a big capacitor to the load side of the battery switch. This may keep the voltage up on the load side so that the instruments and devices with a memory will not crash during battery changeover. Use at least a 500,000 µF capacitor with a voltage rating of at least 50 Volts. Since caps that big are hard to find and expensive, you can parallel several smaller capacitors to attain the required capacity. Richard

Pumping

I discovered your excellent magazine while browsing through the alternate energy section at my local Barnes & Noble bookstore. Despite the availability of cheap energy, it is clear that alternative energy is alive and well, and you are doing an excellent job in providing a unique service to your readers.

We own a vacation cabin on the largest lake in Maine, several miles from the nearest electric utility. We have gas lights, a gas stove, and an old Servel gas refrigerator, all powered by bottled propane, brought in by boat. Our water needs are presently being met by a hand powered pitcher pump drawing water directly from the lake. Hot water for cooking, bathing, and washing dishes is obtained by heating a large pail of water over the stove. Only one thing is missing—a nice hot shower!

We are exploring the possibility of pumping water to a storage tank, either pressurized or gravity fed, and heating water with a small propane water heater, and would like your advice. Since the cabin is only used about 30 days a year, it seems hard to justify a full-blown photovoltaic system. What about a 12 Volt pump used for marine or RV water systems powered by 12 Volt storage batteries? The batteries could be recharged at home on a weekly basis. In order to size the pump and the batteries, we need to estimate the pressure and volume requirements. Any suggestions?

We are also considering the ultimate low-tech solution: using a hand pump to pump our daily needs to an elevated storage tank, and let gravity do the rest. What kind of output is the human body capable of? Is this a subject you have considered in a previous issue? Keep up the good work! Richard Caron, Salem, New Hampshire

Hello Richard. Weekend cabin-sized PV systems are less expensive than you may think. The system has all week to recover and recharge before the next weekend. Often one or two PV modules are enough to do the job. If you want to pump water, then electricity is the best power source. Hauling batteries back to town every Sunday night gets old very quickly. Not only are batteries heavy, but they are a danger to folks in the car in the event of an accident.

A shower will use between two and five gallons per minute. Most water-using appliances are designed to work on city water pressure (30–40 psi). We've found most of them work well on pressures as low as 10 psi. We tried a human-powered, pumping experiment the first year we moved to Agate Flat (1970). There were five of us to pump, but we could not keep our veggie garden alive. I figure we pumped between 200 and 300 gallons per day. A human can put out about 50 to 100 Watts of power for a few minutes. If you are considering human-powered pumping, use a bicycle setup and work your legs, not your arms. If your water needs are small (say under 50 gallons per day), then human-powered pumping may work for you.

I'd consider installing a small PV system on your cabin. It would provide lights at night (save on propane), energy for electronics/communication and power for water pumping and pressurization (often cheaper than building a water tower). A two module systems should cost less than $2000 complete with pumps and batteries. Richard

Home Power MicroAds

Rates: 10¢ per CHARACTER, include spaces & punctuation. $15 minimum per insertion. Please send check with ad. Your cancelled check is your receipt.

SIEMENS SOLAR POWERED Portable Lantern, Built in solar cells with 3-hour battery, power this bright 6-watt fluorescent lantern. Rugged, 1-year warranty, New in box. Retail $129, Whsl $79. Closeout $50+$5 S&H. Spook Hill Ent., P O Box 367: Apache Jct., AZ 85220 (602)986-5876

SERVEL REPAIRS—We repair & rebuild all makes of propane refrigerators. This includes cleaning all pressurized lines & replacement of ammonia. All work guaranteed. For details call OWENS 520-333-4518, Springerville AZ.

KENTUCKY & SURROUNDING States Renewable Energy dealer/installer: PV, hydro, alternative fueled appliances, more. Catalog $3. EKAT, 150 Gravel Lick Rd, Dreyfus, KY 40385, (606)986-6146

WANTED TO BUY for lighting display, old and unusual light bulbs, any voltage, Edison, Mazda, ect. Describe and price. Have big red “ruby glass” bulbs to trade. Richard Bock, 1001 Meadow Lane, Fortuna, CA 95540

WOULD LIKE TO BUY used 500 to 3000 watt wind generator reasonably priced. Prefer Bergey or Northern Power Systems. Call Jim 806-488-2401.

WIND/SOLAR ELECTRICITY generating equipment. Water/air heating. Catalog $5. Staber 2300 Washers, Trace SW4024, SV modules, etc. Solar Creations 2189 SR 511S Perrysville, OH 44864 419-368-4252

SOLAR ELECTRIC PANELS. new single crystal, 4” cells in glass and aluminum frame 100 watt (12 or 24 volt) 72 cells $400 ea., 40 watt 30, 4” cells $125 ea. (805) 373-9433

POWER CENTER, used APT5-444-24V with ac section, $1,300. Trace DR1524-$700. Solarex MSX-53-new $300. More items new and used. Call (502)889-0624.

VERMONT DEALER. Come and visit my new well stocked and informative S.O.S. (shop, office, showroom) building in our off-grid PV and microhydro powered neighborhood. Helping do-it-yourselfers with free professional design advice for 9 yrs. Sales of new and used equipment, installations and service. Free educational workshops (see Happenings). Quality components at competitive prices. Trojan batteries in stock. Hot prices on Sun Frost refrigerators! Used Siemens M-75’s $200. Used TRACE inverters 2012SB DVM $500, 2012SB DVM ACTC $725. Overstocked Inverters—new Power Stars, UPG 400W $200, 700W $250. reconditioned 1300W $450. Westerfield AC mag ballasts for 2 pin CF’s $4.50, specify 13W, or 7/9W. Large supply of wire and cable. Overstocked and used controllers and meters. Independent Power & Light, RR 1 Box 3054, Hyde Park, Vermont 05655 call or fax David Palumbo 802-888-7194. No catalog requests please. Please call for appointment before visiting.

CYBER II, measurement, control, robotics unit. Connects com port, your PC. Includes program. Information: Tesco Automation, Box 6216, Lubbock, TX 79493

94 ACRES IN NORTHERN Calif. $98,500 w/terms. Cozy solar elect cabin; well & septic; southern exposure; xlnt wind site; breath taking view; totally private. Call Secluded Properties 707-994-1277, POB 606 Lower Lake CA 95457

SALESPERSON—SOLAR ELECTRIC—SunWize Energy Systems, Inc., a Besicorp Company located in Kingston, NY, is seeking an experienced, ambitious and aggressive salesperson to assist in selling a line of photovoltaic products. The individual we are seeking must be technically cognizant and familiar with electronic and electrical equipment. PV or other electrical sales experience a plus. Must be well organized, self-starter available for occasional travel. Send resume and salary requirements to: T. Nickolich, Besicorp Group Inc., 1151 Flatbush Road, Kingston, NY, 12401, or fax resume to (914) 336-7172. We are an equal opportunity employer.

INVERTER—24V 2500W HEART works great, exclnt cond. runs washing machines, power tools, computers, etc. $520 + shppng call Romain 541-592-2311 for info

PASSIVE SOLAR DESIGN Software for PCs. For heat gain and shade cooling. PC-Solar™ 2.0, $45 ppd. Free info. 3-D Software, POB 220, Mapleton OR 97453. http://www.teleport.com/~solar3d

LOWEST PRICES on name brand solar products. Call or write SunWorthy Solar Electric, 4105 Witty Ln., Hopkinsville, KY 42240. (502)889-0624

TRACE SW4024, 4KW, Sine Wave, 24V, with Cruising E-Meter $1500. Heart Freedom 25, 2.5KW, 24V, with Link 2000 $1250. All unused in box. 818-265-8443

WATT-HOUR METERS starting at $49.95 (120VAC) completely reconditioned utility company grade meets UL specs. Call Solar Utility Network at (817) 799-4909

DISPOSAL OF BATTERY Project. Nickel Iron, NiCd + 250A.H. down, many sizes, some have been recycled and have new electrolyte. All must go. Some as small as 9A.H. Battery cycling power supplys and load resistors. 3 wood gasifiers—run your large gas engine from wood gas. 60ft very hvy 4 leg windmill tower + hvy dty winch, presently set up for Whisper 1000, $500 Send for info, list, specify interest. All cheap, out they go! Pick up only! Robert Mosher 18017 W County A, Evansville, WI 53536 1-608-862-3086

STORE ABUNDANT ENERGY cheaper without storage batteries. Much more durability, less investment. Start a 5 HP motor without strain or surge problems. Simple maintenance. Theory, general plans $15, Efficiency Research, Box 102, Hartley, Texas 79044

JACOBS 2500W 32V (works great w/24V system) w/orig control box conv to solid state+orig parts. Wood pole adaptor, guy wires, all hardware. Inc free 48’ pole if you haul. Exc cond can ship $2900+ship Ohio 614-946-6611

TRACE 724 $400. 724SB $450, both new. APT5-404 Powercenter, loaded, new $1600. WATTSUN 8 SX dual axis tracker, new $800. SOLARJACK SDS-228 sub pump, new $500. Pacific Chloride 85-33 cells, 1650 Ah, 12 two volt cells, new $450 each. 200 amp 2 pole disco switches, new $120. Mike@707-459-0504.

WATER PUMP FOR SALE Flowlight 12V Booster Pump for pressurized system. Pump used six summers, mostly on weekends, stored for Winter. New was $400, asking $100. (804) 967-9925.

WANTED 65KW INVERTER for non-profit organization. Will consider larger/smaller. Contact Paul Franklin 909-585-7225

TRACE 2624 INVERTER w/standby option $900, new condition; Vanguard/Briggs 5 kw LP gas generator, auto remote start/stop $1500. 715-762-4985

WINDGENERATOR 12V 250W weighs 14 lbs. has electrical/overspeed control $319 includes shipping options available Solar Powered lighting for roadway yards etc. 1-800-363-4831.

BATTERIES, CHARGERS, GEN-SET: Used 2 Volt stationary batteries; 1, 450 AH C&D wet cell (210 lbs/cell) $62 each; 2, 280 AH Dynasty Gel-cell (315 lbs/cell) $200 each; 2, 640 AH C&D wet-cell (305 lbs/cell) $200 each. 75 Amp 12 Volt Todd PowerSource charger $200 each; 30 Amp 24 Volt IBE charger $200; 162 Amp 24 Volt Hobart charger, 3-phase input (about 400 lbs) $1,150; 48 VDC, 3500 watt OLD Retalco inverter (about 500 lbs) $225; 24 VDC, 3000 watt Vanner inverter like new $950 each; Several 15KW diesel gen-sets, 120/240 VAC 1 & 3 phase (about 2,500 lbs) extended-run pkg, priced from $2,500. (707) 895-2228

The two numbers at the end of each entry (e.g. 31-108) refer to the issue number and page number.

The two numbers at the end of each entry (e.g. 31-108) refer to the issue number and page number.

The two numbers at the end of each entry (e.g. 31-108) refer to the issue number and page number.

The two numbers at the end of each entry (e.g. 31-108) refer to the issue number and page number.

The two numbers at the end of each entry (e.g. 31-108) refer to the issue number and page number.

The two numbers at the end of each entry (e.g. 31-108) refer to the issue number and page number.

The two numbers at the end of each entry (e.g. 31-108) refer to the issue number and page number.

For information on ordering Home Power back issues:

See page 80 for a Quick Start back issue special.

See page 81 for all back issue availability and rates.

See page 87 for special deals on Home Power back issues.

For computer users see page 52 for Home Power back issues on CD-ROM.

Call 800-707-6585 (inside USA) or 916-475-0830 (outside USA) to order back issues

Index to Advertisers

HOME POWER

THE HANDS-ON JOURNAL OF HOME-MADE POWER

ISSUE #53

June / July 1996

$4.75 U.S.

$6.60 CAN.

Display until August 1